# THE American JOURNAL OF Surgery

MAY 1957

THURSTON SCOTT WELTON, M.D., EDITOR

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# THE American JOURNAL OF Surgery

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(1) Farmer, D. A.: M. Clin. North America *38*:1403, 1954. (2) Lichtman, S. S.: Diseases of the Liver, Gallbladder and Bile Ducts, ed. 3, Philadelphia, Lea & Febiger, 1953, vol. 2, pp. 1146, 1150, 1302. (3) Rosser, J. H., and McCall, R. A.: U. S. Armed Forces M. J. *5*:658, 1954. (4) Schwimmer, D.; Boyd, L. J., and Rubin, S. H.: Bull. New York M. Coll. *16*:102, 1953. (5) Best, R. R.; Rasmussen, J. A., and Wilson, C. E.: A.M.A. Arch. Surg. *67*:839, 1953. (6) Pearse, H. E.: Am. J. Surg. *89*:1191, 1955.

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1. Zintel, H. A.: *Surg. Clin. North America,* 36:257, Apr., 1956. 2. Freeman, B. S.; and Young, T. K., Jr.: *Arch. Surg.,* 61:1145, Dec., 1950.

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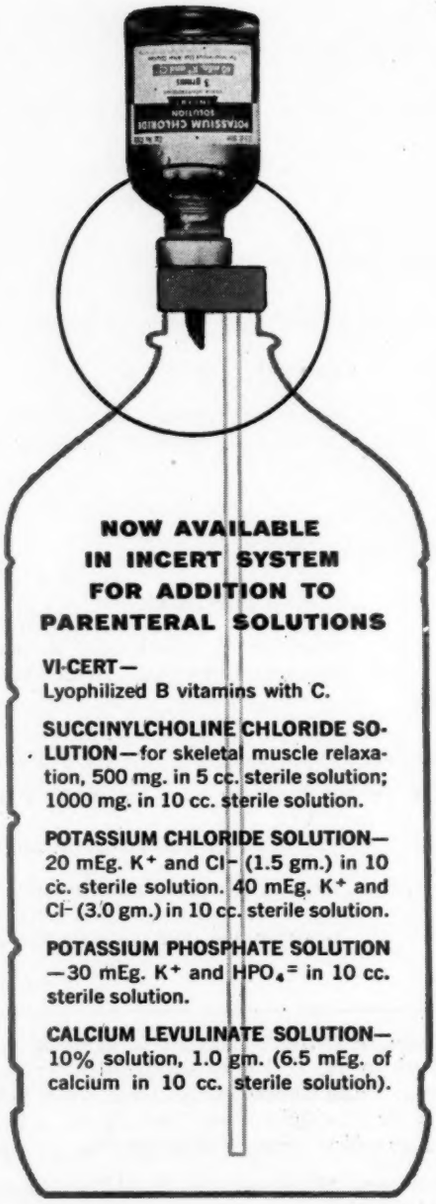

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HAROLD M. CHILDRESS

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ARTHUR M. DICKINSON

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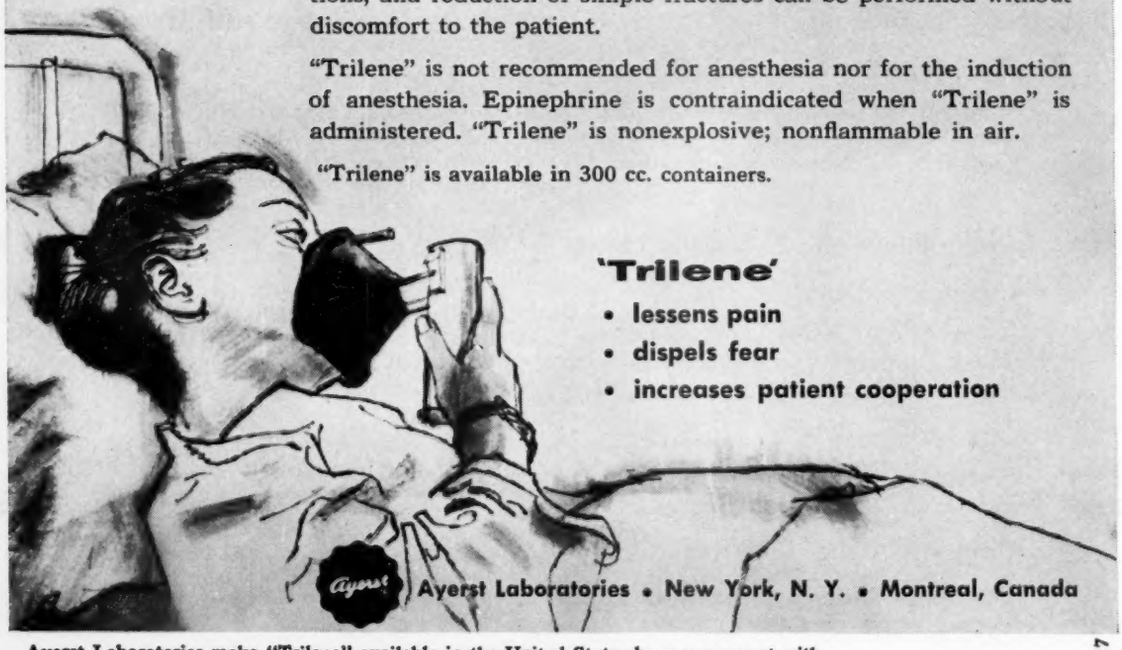

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ROBERT E. FLORER

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**Elman, R.: Protein Needs in Surgical Patients, J. Am. Dietetic Assn. 32;524 (June) 1956.*

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A. W. SANDERS AND S. D. KOBERNICK

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1. Elman, R., and Cannon, P. R., in Clinical Nutrition, Jolliffe, N., et al., eds., New York, Paul B. Hoeber, Inc., 1950, p. 183.

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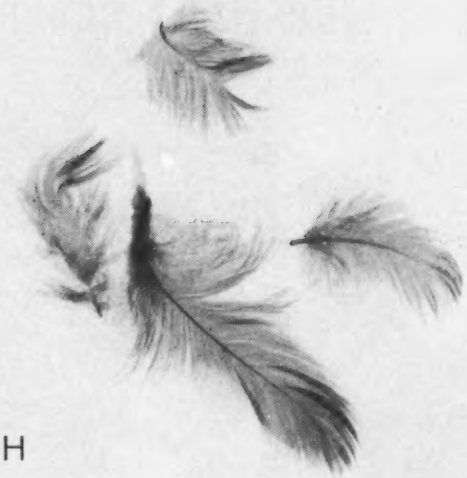

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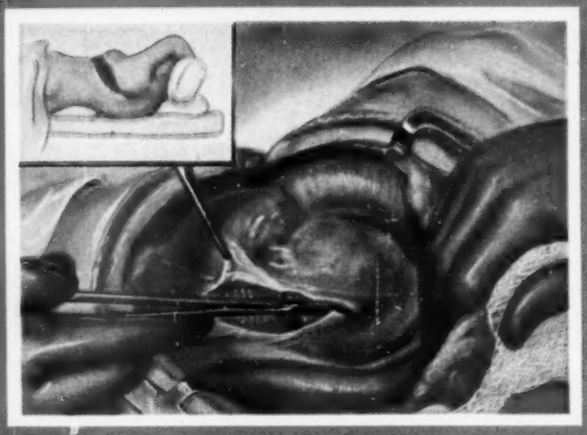
***No. 1 in professional preference because they are No. 1 in surgical performance***

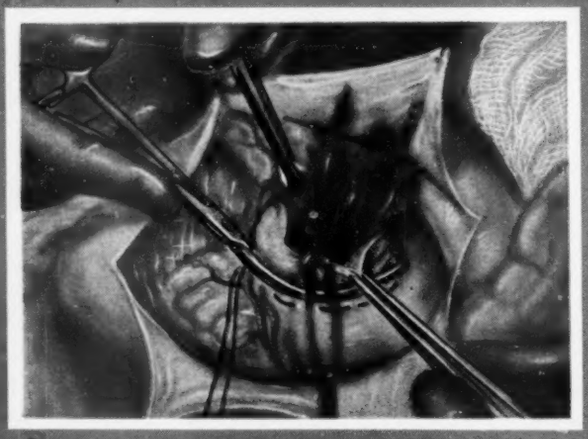
# KEY ADVANCES IN OPERATIVE TECHNICS*—*Mitral Commisurotomy*[1]

**1.** Interior postero-lateral view of heart. Note greatly dilated left auricle and calcified, thickened mitral valve. Inset shows typical narrowing of valve viewed from above.

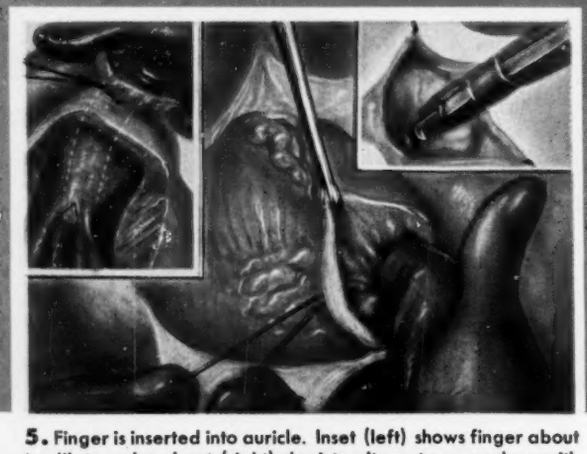


**2.** Postero-lateral periscapular incision. Enlargement of left ventricle and pulmonary artery is evident. Dilated left auricle presses on esophagus. Pericardium is being incised just posterior to the phrenic nerve.

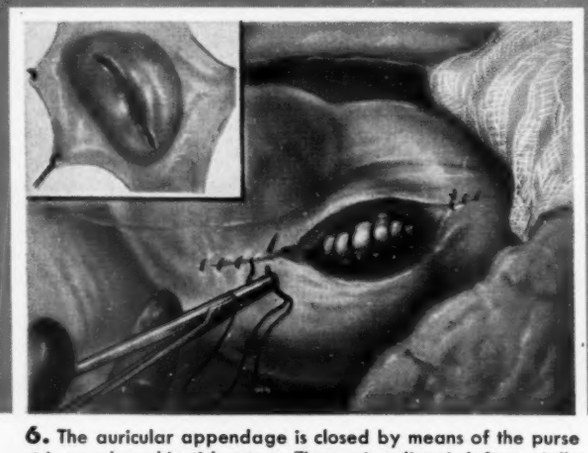
**3.** A purse string suture is placed around the auricular appendage. This suture is carefully started just above the circumflex artery.



**4.** A clamp placed just above the suture line is released slightly allowing a gush of blood to wash away any accumulated thrombotic material. Purse string suture is then tightened.



**5.** Finger is inserted into auricle. Inset (left) shows finger about to dilate valve. Inset (right) depicts alternate procedure with guillotine knife fastened to finger for rigid valve.



**6.** The auricular appendage is closed by means of the purse string and a whipstich suture. The pericardium is left partially open. Inset shows an adequate commisurotomy.

**Mitral commisurotomy** is one of a series of surgical drawings in color illustrating important new operations successfully perfected during the past decade. It is brought to you as a service by Seamless, the world's largest manufacturer of surgeons' gloves. If you would care to examine any of the Seamless Gloves . . . Brown Milled, White or Brown 'Limber-Latex', or the new 'Crest' for eye, brain or heart surgery, write for a sample giving your glove size.

**Based on an opinion survey of 2,500 general surgeons.*

1. Glover, R.P., *International Symposium on Cardiovascular Surgery*, Edited by Conrad R. Lam, (Philadelphia: W. B. Saunders Company, 1955), pp. 179-211.

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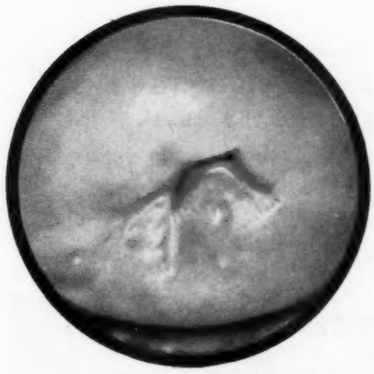

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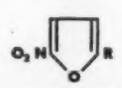

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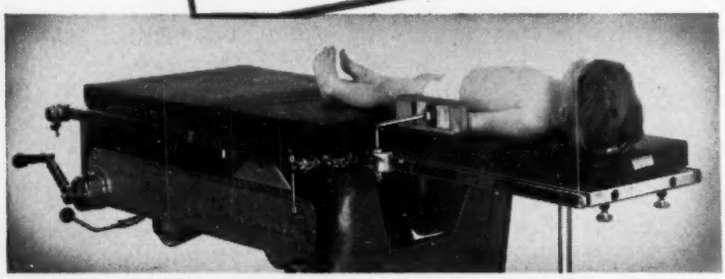

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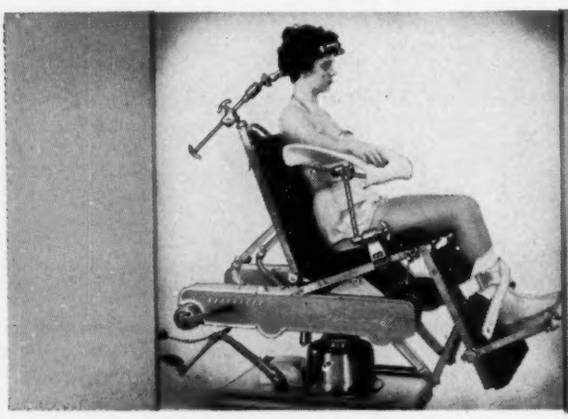

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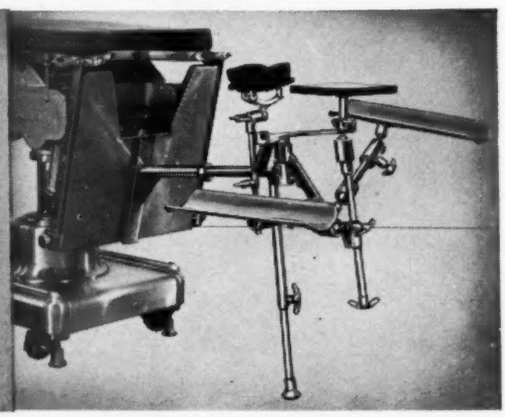

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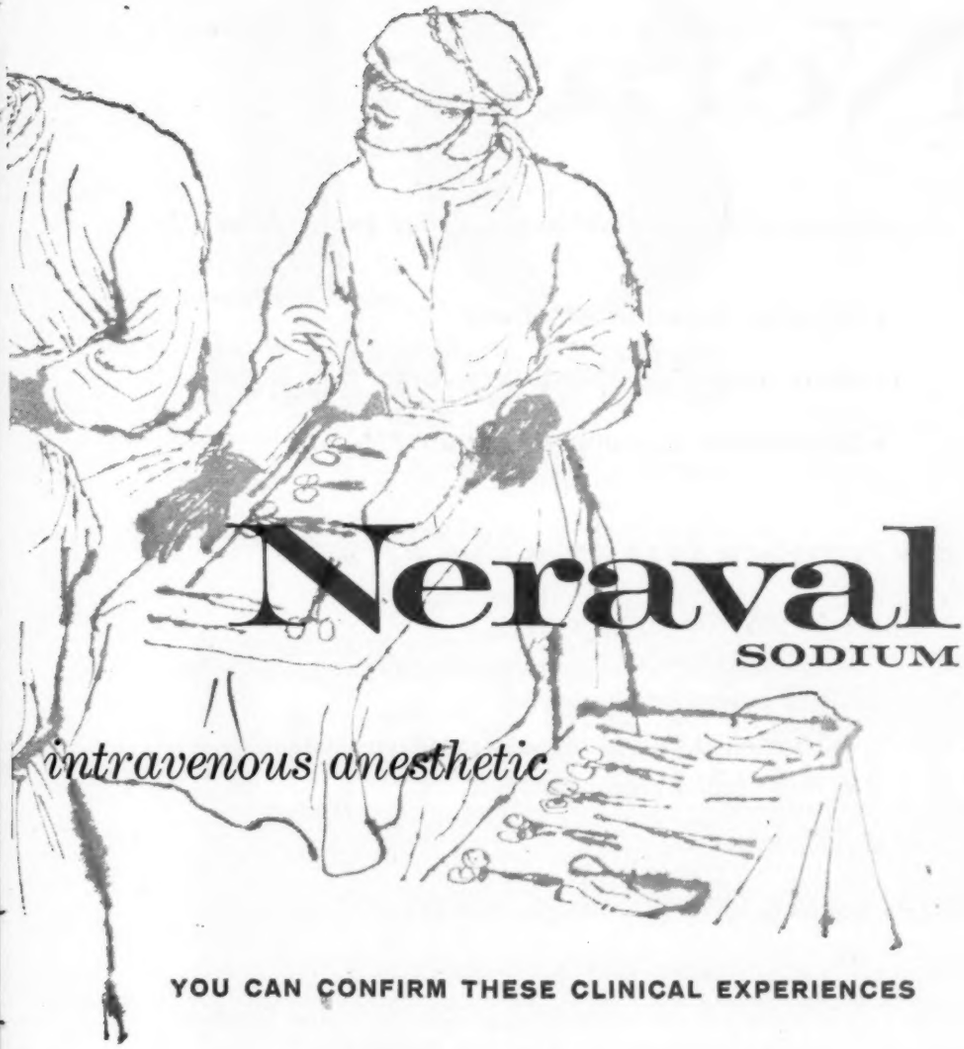

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- Considerably less accumulation[3,4,6]
- More rapid, complete recovery[3,5-7]
- Strikingly rapid awakening[1,3,5]
- Better moment-to-moment control[3]
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- Diminished cumulative action[2-4,6,8]

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BIBLIOGRAPHY

(1) Boone, J.D.; Munoz, R., and Dillon, J.B.: Anesthesiology *17*:284, 1956. (2) Zima, O.; von Werder, F., and Hotovy, R.: Anaesthesist *3*:244, 1954. (3) Fitzpatrick, L.J.; Clarie, D'A.C., and Mersch, M.A.: Anesthesiology *17*:684, 1956. (4) Blake, M.W., and Perlman, P.L.: J. Pharmacol. & Exper. Therap. *117*:287, 1956. (5) Ayd, F.J., Jr.: Neraval: A new anesthetic for electroconvulsive therapy, Paper presented at annual meeting, Electroshock Research Association, Chicago, Illinois, April 29th, 1956. (6) Irwin, S.; Stagg, R.D.; Dunbar, E., and Govier, W.M.: J. Pharmacol. & Exper. Therap. *116*:317, 1956. (7) Reifferscheid, M., and Dietmann, K.: Deutsche med. Wchnschr. *79*:638, 1954. (8) Dietmann, K.: Deutsche med. Wchnschr. *79*:1748, 1954.

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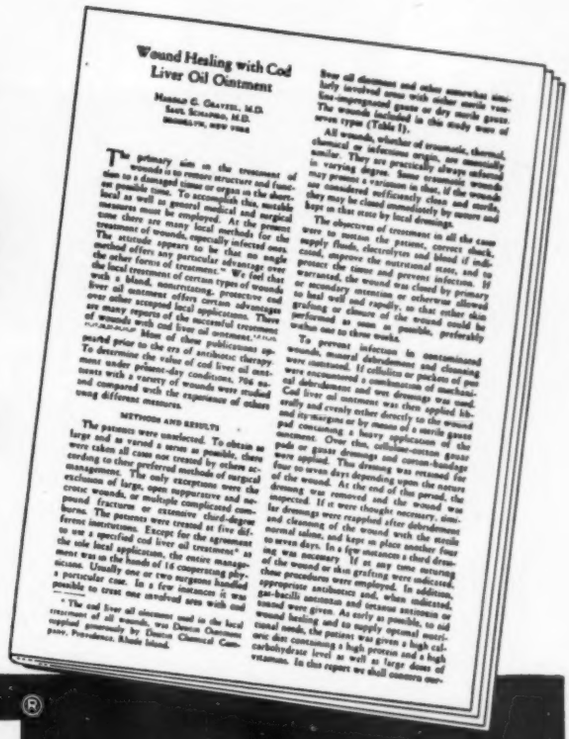

Wound Healing with Cod Liver Oil Ointment

Maurice G. Grayzel, M.D.
Saul Schapiro, M.D.
Brooklyn, New York

The primary aim in the treatment of wounds is to restore structure and function to a damaged tissue or organ in the shortest possible time. To accomplish this, suitable local as well as general medical and surgical measures must be employed. At the present time there are many local methods for the treatment of wounds, especially infected ones. The attitude appears to be that no single method offers any particular advantage over the other forms of treatment. We feel that the local treatment of certain types of wounds with a bland, nonirritating, protective cod liver oil ointment offers certain advantages over other accepted local applications. There are many reports of the successful treatment of wounds with cod liver oil ointment.[1-10] Most of these publications appeared prior to the era of antibiotic therapy. To determine the value of cod liver oil ointment under present-day conditions, 784 patients with a variety of wounds were studied and compared with the experience of others using different measures.

METHODS AND RESULTS

The patients were unselected. To obtain as large and as varied a series as possible, there were taken all cases not treated by others according to their preferred methods of surgical management. The only exceptions were the carcinomas of large, open suppurative and necrotic wounds, or multiple complicated compound fractures or extensive chord-degree burns. The patients were treated in five different institutions. Except for the agreement to use a specified cod liver oil treatment as the sole local application, the entire management was in the hands of 16 cooperating physicians. Usually one or two surgeons handled a particular case. In a few instances it was possible to treat one involved area with cod liver oil ointment and other somewhat similarly involved areas with either sterile vaseline-impregnated gauze or dry sterile gauze. The wounds included in this study were of seven types (Table I).

All wounds, whether of traumatic, thermal, chemical or infectious origin, are essentially similar. They are practically always infected in varying degree. Some traumatic wounds may present a variation in that, if the wounds are considered sufficiently clean and sterile, they may be closed immediately by sutures and kept in that state by local dressings.

The objectives of treatment in all the cases were to sustain the patient, correct shock, supply fluids, electrolytes and blood if indicated, improve the nutritional state, and to protect the tissue and prevent infection. If warranted, the wound was closed by primary or secondary intention or otherwise allowed to heal well and rapidly, so that either skin grafting or closure of the wound could be performed as soon as possible, preferably within one to three weeks.

To prevent infection in contaminated wounds, thorough debridement and cleansing were instituted. If cellulitis or pockets of pus were encountered a combination of mechanical debridement and wet dressings was used. Cod liver oil ointment was then applied liberally and evenly either directly to the wound and its margins or by means of a sterile gauze pad containing a heavy application of the ointment. Over this, cellulose-containing gauze pads or gauze dressings and custom-bandages were applied. This dressing was retained for four to seven days depending upon the nature of the wound. At the end of this period, the dressing was removed and the wound was inspected. If it were thought necessary, similar dressings were reapplied after debridement and cleansing of the wound with the sterile normal saline, and kept in place another four to seven days. In a few instances a third dressing was necessary. If at any time maturing of the wound or skin grafting were indicated, these procedures were employed. In addition, appropriate antibiotics and, when indicated, gas-bacilli antitoxin and tetanus antitoxin or toxoid were given. As early as possible, to aid wound healing and to supply optimal nutritional needs, the patient was given a high caloric diet containing a high protein and a high carbohydrate level as well as large doses of vitamins. In this report we shall concern ourselves

* The cod liver oil ointment used in the local treatment of all wounds, was Desitin Ointment, supplied generously by Desitin Chemical Company, Providence, Rhode Island.

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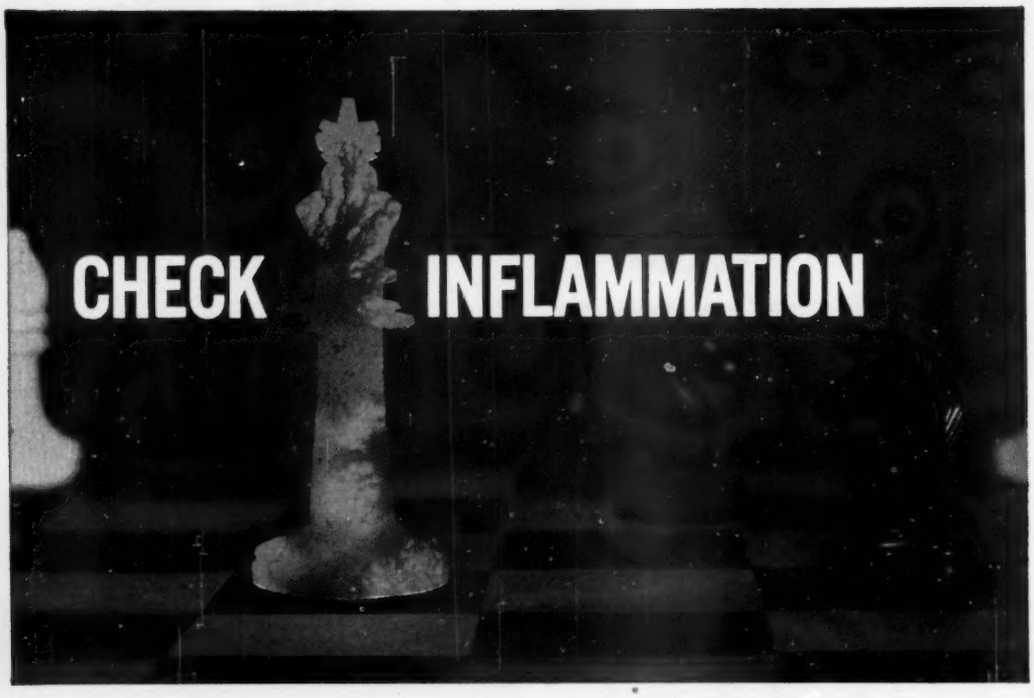
1. Grayzel, H. G., and Schapiro, S.: Western J. Surgery, Obstet. & Gyn., Oct. 1956.

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1. Miller, J. M.; Surmonte, J. A.; Ginsberg, M., and Ablondi, F. B.: Postgraduate Medicine 20:260 (Sept.) 1956.

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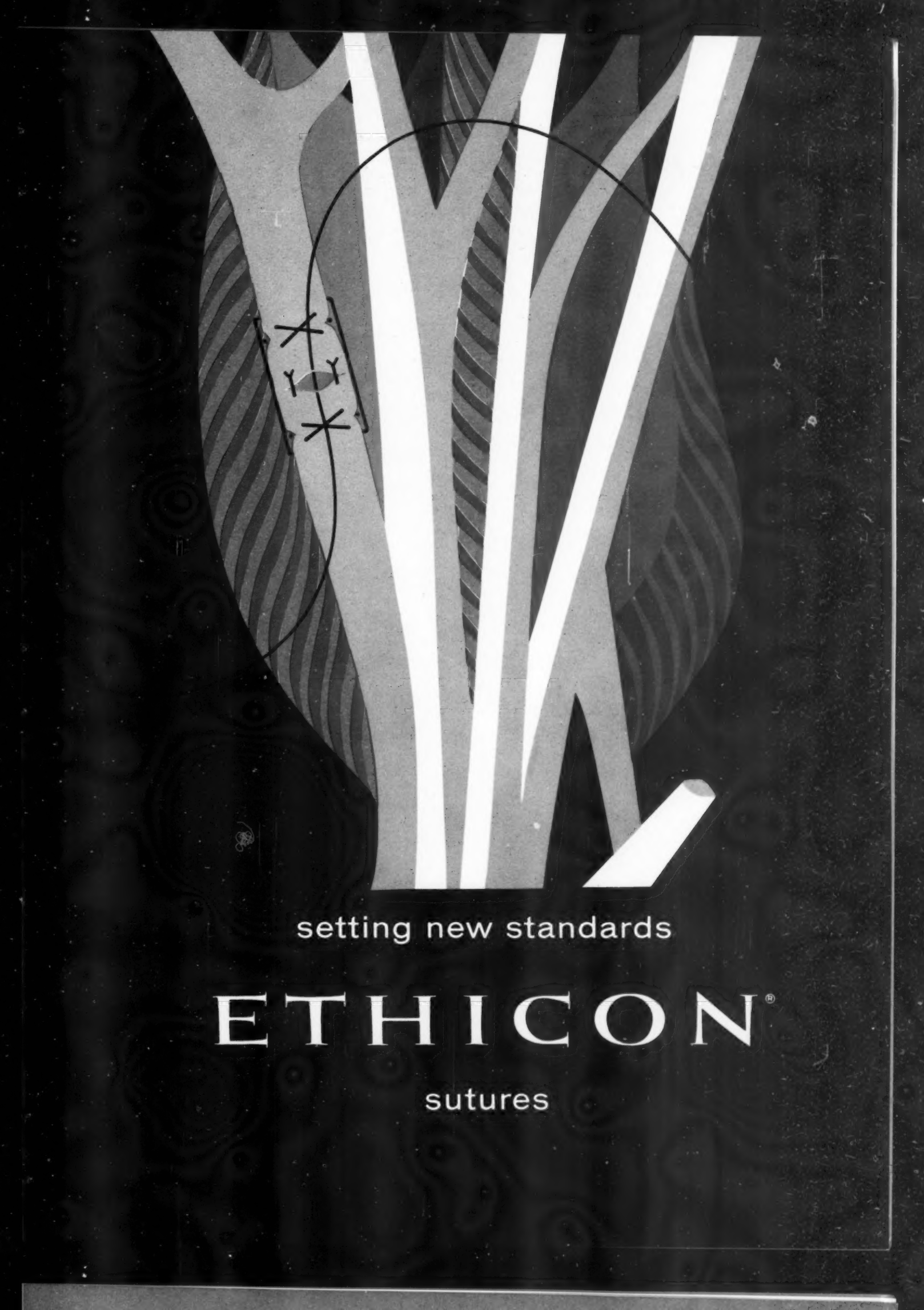
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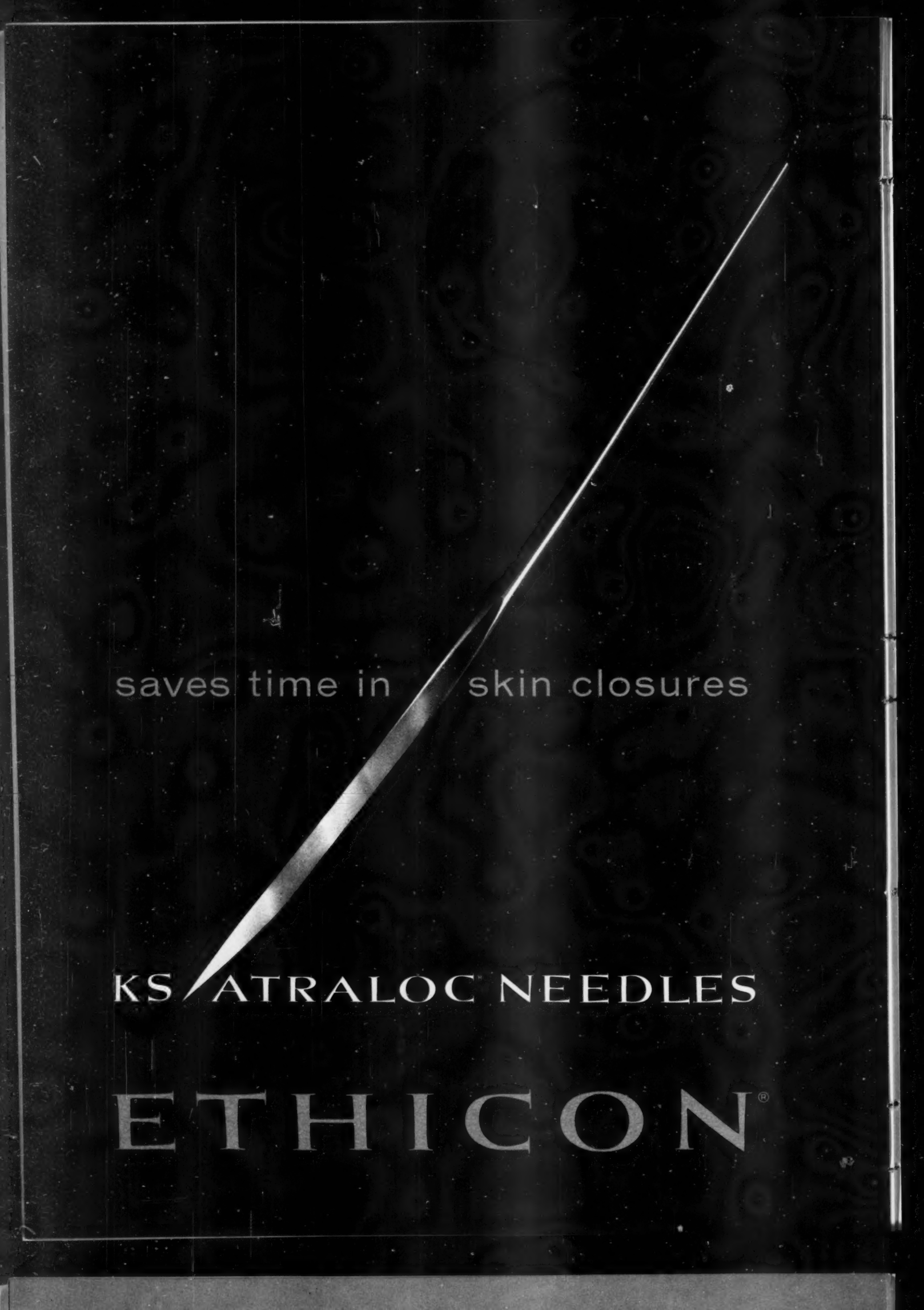
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1. Bacala, J.C.: The Use of the Systemic Hemostat, Carbazochrome Salicylate, West. J. Surg. *64*:88 (Jan., 1956)

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Owings, Capers B.: The Control of Postoperative Bleeding with Adrenosem, Laryngoscope *55*:21 (Jan., 1955)

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Riddle, A.C., Jr.: Adrenosem Salicylate: A Systemic Hemostat, Oral Surg., Oral Med., Oral Path. *6*:617 (June, 1955)

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**References:** 1. Gamble, J.R., et al. Arch. Int. Med. 95:52, 1955. 2. Gamble, J.R., et al. J. Lab. & Clin. Med. 42:805, 1953.

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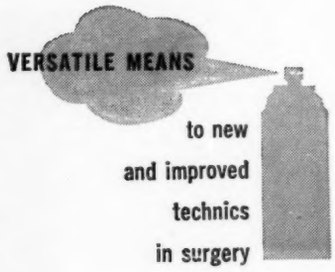


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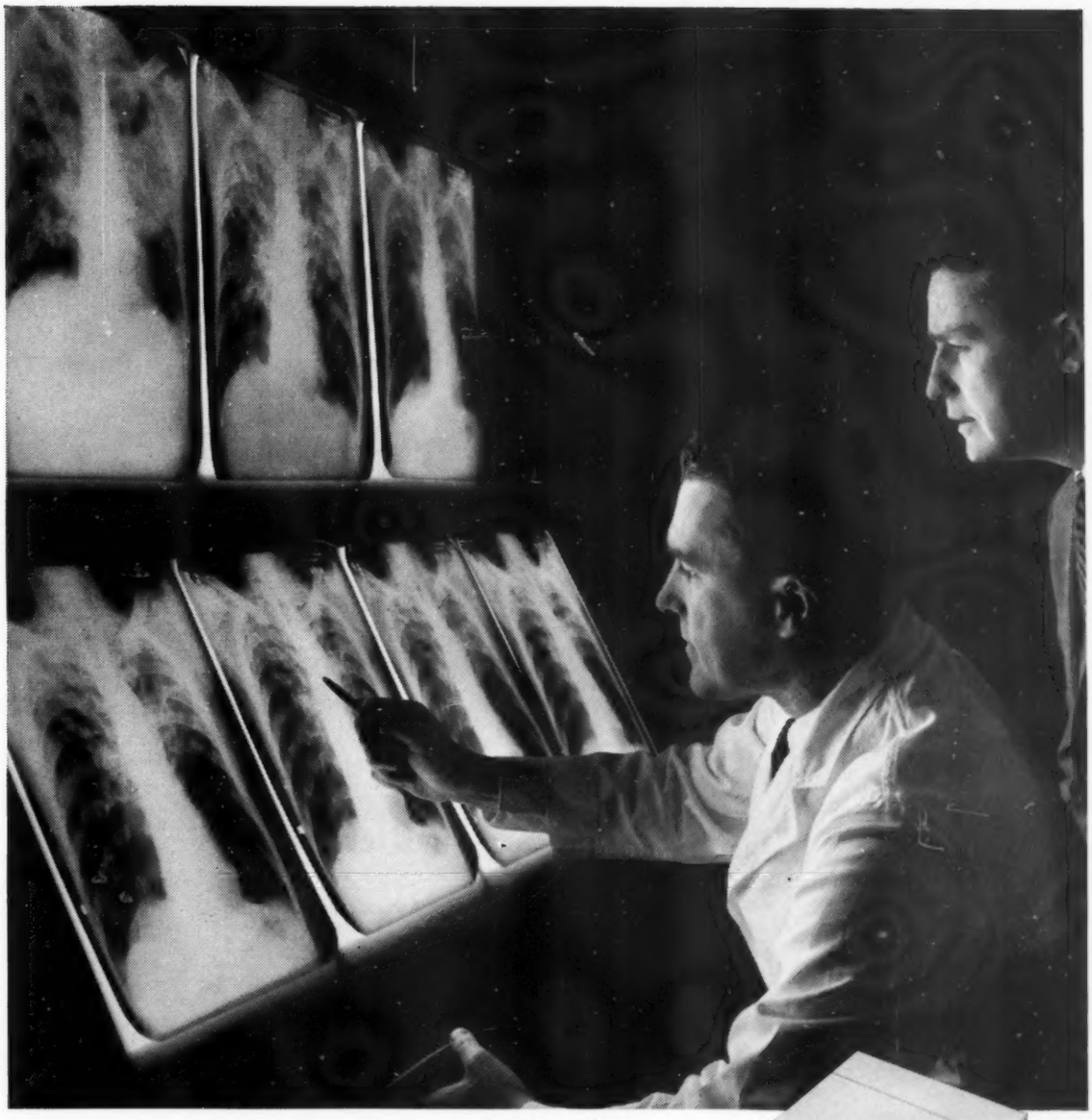

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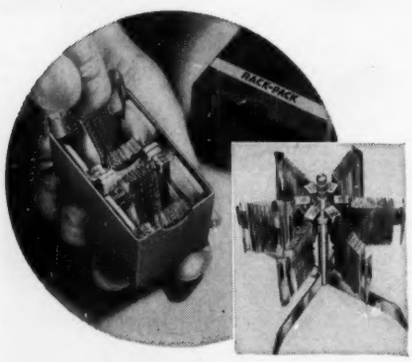


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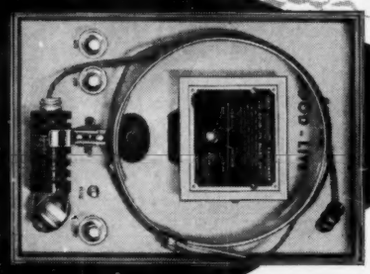

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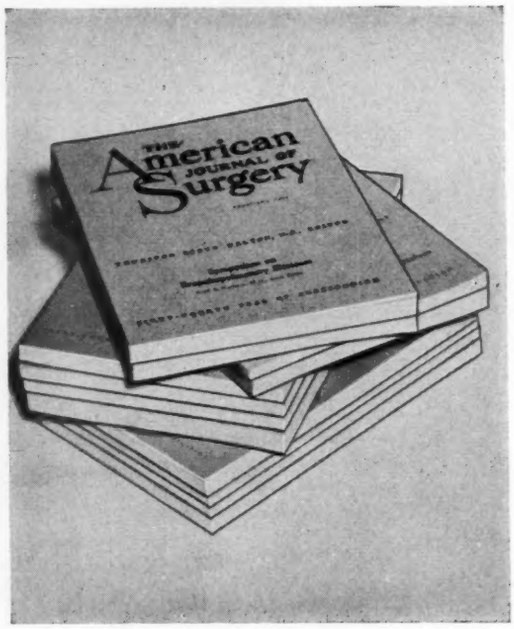


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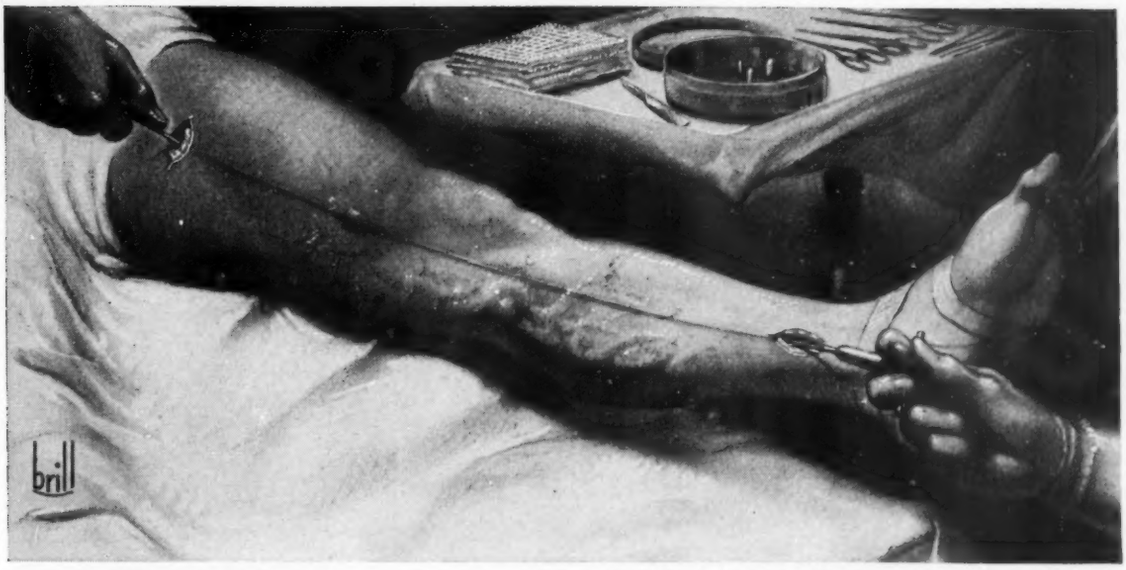


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EDITORIAL

# Attempts in Improving the Results Following Total Gastrectomy

We have been interested in improving the postoperative comfort and nutritional status of the patient after total gastrectomy. We were stimulated in trying to improve upon the standard procedure of total gastrectomy because of the discomfort and distress many patients experience postoperatively due to reflux esophagitis, secondary anemia and malnutrition. The accepted procedure provides no capacity for the intake of food and does not completely divert the duodenal contents away from the anastomosed esophagus. Often, because of these disagreeable aftermaths of total gastrectomy, the patient is in more distress after the operation than he was before.

It was our belief that some method should be devised to divert the duodenal contents from contact with the esophagus and at the same time provide a pouch to afford a greater capacity for food intake than that available in the operation of esophagojejunostomy with enteroenterostomy. We concluded that if the enteroenterostomy was extended and made extremely long, and the proximal limb was divided proximal to the anastomosis, a large food pouch could be made and the patient could eat an adequate meal.

The proximal jejunum is in turn anastomosed to the side of the distal limb of the severed jejunum below the long anastomosis by the Roux-en-Y method. This completely diverts the duodenal contents and eliminates reflux esophagitis. We believe that the Roux-en-Y procedure should be a part of total gastrectomy when reconstruction of the esophagointestinal tract is effected by esophagojejunostomy.

This procedure of making a food pouch out of the jejunum and diverting the duodenal contents by the Roux-en-Y method has been employed by us ten times. Two postoperative deaths occurred in the hospital, one from esophagojejunal leakage and the other from a colonic fistula, occasioned by a devitalized colon, unknowingly produced in the process of disconnecting a previously performed posterior gastroenterostomy.

The food pouch made by this method is usually larger than the segment of stomach left after radical subtotal gastrectomy for duodenal ulcer. These patients could and did eat a large meal and seemed to enjoy it. Those who survived several months gained weight, did not become anemic, had increasing strength due to adequate food intake and did not have distress from reflux esophagitis with its progressive associated dysphagia.

These observations, contrasted with fifteen cases of total gastrectomy performed by the standard procedure of esophagojejunostomy with enteroenterostomy, were so outstandingly favorable that we no longer consider performing the usual procedure for total gastrectomy. We strongly advocate this method of making a food pouch out of the jejunum and the associated Roux-en-Y procedure in all instances in which total gastrectomy is required and intestinal continuity is restored by esophagojejunostomy.

*Segmental Intestinal Replacement of Stomach.* Attempts have been made to replace the stomach with some segment of the intestinal tract. These procedures have been received with reported success but neither this method of stomach replacement with an intestinal segment nor our procedure of making a jejunal pouch as a food reservoir has been widely used. The standard operation of esophagojejunostomy with a relatively small enteroenterostomy is still the procedure most usually employed.

Some surgeons have elected to employ segments of the colon to replace the stomach after its total removal, and some have used segments of the upper jejunum.

The right colon has been a good substitute for the stomach. Contrary to what one would expect, it seems to function effectively. It certainly makes a large reservoir for food, and prevents regurgitation and esophagitis through the competency of the ileocecal valve.

To me, it seems anatomically and physiologically undesirable to use the right colon as a substitute for the stomach. Anatomically it is too large, thin-walled and bulky; physiologically it materially alters the fluid absorption properties of the intestinal tract. It may result in dehydration and frequent loose stools, a disagreeable feature often encountered after right colectomy for organic disease.

The procedure of replacing the stomach with the right colon is time-consuming and formidable, and should be undertaken only by a master surgeon.

Little can be said for the substitution of the stomach with a segment of the transverse colon except that it is more accessible than the right colon and does not disturb intestinal physiology as does replacement with the right colon. When replaced to substitute for the stomach, it is antiperistaltic.

I do not believe that any segment of the colon was ever intended by nature to be used as a substitute for the stomach. The colon is primarily an agent for fluid absorption and a tubular reservoir for the collection of debris to be expelled later. If the stomach is to be replaced with any segment of the intestinal tract, it seems more logical to use a segment of the nearest small intestine, a structure anatomically and physiologically more adaptable for replacement. Intestinal physiology is not altered by this procedure.

In several publications I have discussed the relative merits of jejunal replacement as it especially applies to total gastrectomy. Longmeir has replaced the removed stomach with a single segment of the jejunum. This maintains the esophagoduodenal relationship with the hope of retaining an adequate nutritional protein balance. It provides no food reservoir for adequate food intake.

I propose, in place of a single segment of the jejunum, a double segment which at the same time maintains the esophagoduodenal relationship. A much longer segment of the jejunum is brought up anterior to the colon or through the mesocolon, depending upon the length of the jejunal mesentery, doubled upon itself, and the two parallel limbs of bowel are anastomosed together, thereby providing a large food reservoir.

It has not been proved that the interposition of a segment of the intestinal tract, small bowel or colon, is superior to esophagojejunostomy with the Roux-en-Y procedure and the formation of a food pouch out of the distal jejunum, as I advocated in 1951.

Henley and Watkins in certain instances have replaced a segment of the stomach in subtotal gastrectomy with a portion of the jejunum and a segment of the transverse colon, respectively. This has been advised to maintain the normal gastroduodenal relationship with the idea of better nutritional balance and to eliminate the dumping syndrome. In certain instances of recurrent gastrojejunal ulcer (or stomal ulcer) after subtotal gastric resection, a restoration of gastroduodenal integrity by this method has been advised. The reported incidence of recurring ulcer exceeds that following radical subtotal gastrectomy for duodenal ulcer.

CLAUDE J. HUNT, M.D.,
*Kansas City, Missouri*

# Traumatic Peripheral Aneurysms

JOHN T. LLOYD, M.D., *Louisburg, North Carolina*

HUFNAGEL has said, "All aneurysms are progressive in nature and, if untreated, lead to disaster." A discussion of the pathogenesis, recognition, preparation, surgical treatment and postoperative care of this serious disease, with a report of three cases, follows. The reference sources, particularly the excellent paper of Albright and Van Hale [*1*], have been freely quoted. These articles merit the earnest study of any physician undertaking the treatment of aneurysms.

Regarding the mechanism of production of aneurysms, Gage [*8*] recognized four types of arterial injury, as follows: (1) destruction of a large segment of artery, (2) severance with destruction of stumps, (3) partial severance, and (4) contusion. He believes that aneurysms can form in groups 2, 3 and 4. Ten cases of arterial injury were listed by McSwain and Dively [*12*] as follows: bullet wounds, seven; knife wounds, one; surgical, one; intravenous needle, one.

Albright and Van Hale [*1*] classify injuries more simply as complete and partial severance, and do not believe that complete severance is compatible with formation of aneurysm. The well known ability of arteries to contract and seal when completely severed makes this view more credible. However, the formation of an aneurysm in a securely ligated artery stump does occur (Case IV). Albright and Van Hale recognize that aneurysms may occur in an arterial wall weakened by contusion or scar. In these latter cases true aneurysms, recognizable by the presence of all three coats of the artery, form; these may be contrasted with false aneurysms, consisting simply of clot lined with an ingrowth of endothelium.

The frequency of fatal bleeding in large, gaping wounds involving arteries is emphasized by both authors, who also recognize the high incidence of gangrene of a limb in these injuries if the patient survives.

When the wound is small and the arterial injury incomplete, bleeding into the tissues occurs, with formation of a pulsating hematoma. This bleeding continues until tissue pressure around the hematoma equals arterial pressure. Laminated clot may progressively diminish palpable pulsation in the hematoma, rendering diagnosis difficult. Infection in the hematoma invariably leads to secondary hemorrhage [*8*]. A spreading hematoma in fracture of the femur should suggest associated arterial injury and command exploration [*8*]. The hematoma may dissect sufficiently to cut off collateral blood supply leading to ischemia and gangrene. This change may be further aggravated by vasospasm associated with the original injury. Calcification may occur in the sac as early as three weeks (Bigger [*6*]) from the time it is found (Case I). Distal embolism from the sac occurs, simulating Buerger's or Raynaud's disease.

After production both arterial and arteriovenous aneurysms undergo similar changes: (1) the distal vessels remain patent; (2) the central portion of the hematoma becomes fluid, transmitting the pulse; (3) the sac becomes lined by endothelium; (4) collaterals grow in; (5) the sac presses on collateral and main blood supply threatening ischemic gangrene, and on nerves with sensory and motor disturbances.

In recognizing the late effects of arterial injury it is necessary to bear the possibility of aneurysm constantly in mind. The opening of a

hot, tense, tender, painful aneurysm as an abscess, such as occurred in Case III of this series, seems the height of indiscretion and disaster; yet, as described heretofore, the tense aneurysm with much laminated clot may pulsate little or not at all and mislead even the experienced observer.

Characteristically, the arterial aneurysm is a firm, tense, moderately tender, painful, throbbing mass. The arteriovenous aneurysm is smaller, less tense, tender and painful with more systemic but fewer local complications [*1*]. Differentiating characteristics of arterial and arteriovenous aneurysms are listed in Table I [*1*].

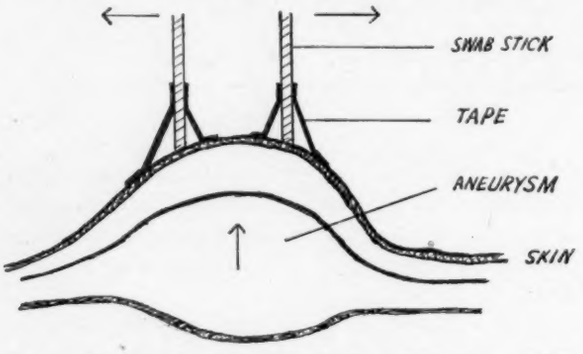


FIG. 1. Eliciting expansile pulsation; Bailey's method.

The importance of examining wounds for pulsation, thrill and bruit cannot be overemphasized [*1*]. The most common sites for arterial aneurysms are [*3*], in order, popliteal, femoral, axillary and carotid. Makins [*6*] lists the site in 523 cases as femoral (35 per cent) popliteal, carotid, axillary, brachial and subclavian.

Pain is usually moderate, of a throbbing or buzzing character. Severe, unremitting pain should signal impending complications. Claudication, coldness, weakness, easy fatigability of extremity, paresthesia and paralysis do occur. The following symptoms were noted in the cases reported herein: (1) pain (all three cases); (2) peripheral nerve changes (Case II); (3) swelling (all three cases); (4) limitation of function (Cases II and III); and (5) local heat (all three cases). Systolic heart murmurs (Makins [*8*]) occur in aneurysm (37 of 180; 18 arteriovenous, 19 arterial).

In large arteries expansile pulsation can be detected by Bailey's method [*24*], simplified by taping each of two pieces of swab stick at right angles to the skin over the swelling. The movement apart of the distal ends of these sticks constitutes *expansile* pulsation. (Fig. 1.) Expansile pulsation and compressibility vary with the thickness of the sac wall. Pulsation distal to the sac presupposes an open channel, whereas absence of this pulsation (Delbet's sign) suggests that collaterals are doing all the work.

Theis [*20*] has emphasized the diagnosis of small peripheal aneurysms oscillometrically, demonstrating by his method small popliteal aneurysms not clinically palpable. The aneurysm produces a sharp peak in the oscillometric curve of the extremity.

TABLE I
DIFFERENTIATING ANEURYSMS

| Arterial | Arteriovenous |
|---|---|
| 1. Expansile mass, larger, more tense and tender | 1. Expansile mass, smaller, less tense and tender |
| 2. Thrill inconsistent | 2. Thrill marked |
| 3. Systolic bruit | 3. Continuous bruit with systolic accentuation |
| 4. Distal pulse usually unchanged | 4. Distal pulse diminished to absent |
| 5. Distal blood pressure usually unchanged | 5. Marked drop in distal blood pressure |
| 6. Temperature usually unchanged | 6. Increased warmth of extremity |
| 7. Compression of proximal artery; no slowing of pulse or rise in blood pressure | 7. Compression of proximal artery; slowing of pulse and moderate rise in blood pressure |
| 8. Distal venous pressure unchanged | 8. Distal venous pressure increased |
| 9. Distal $CO_2$-$O_2$ unchanged. | 9. Distal $O_2$ increased, $CO_2$ decreased |

Surgery should be deferred in the uncomplicated aneurysm until the best conditions for operation and limb survival have been reached. Impending rupture, rapid spread of hematoma or increasing pressure on important nerve or blood supply may advise haste. Such complications occur in 83 per cent of arterial and 50 per cent of arteriovenous aneurysms. When delay is feasible, from four to sixteen weeks should be allowed for the development of adequate collateral circulation. Delay is less important in arterial than arteriovenous aneurysm, but time should be allowed for subsidence of infection, inflammation and contamination. Under these conditions operation can be attempted as early as four to six weeks [*3,4*]. Collateral

blood supply may be improved during this interval by: (1) intermittent compression of the main limb artery, either digitally by the patient or by the Matas compressor (Fig. 2) used up to one hour continuously; the entire limb may be compressed in a pavex boot (not highly recommended); (2) paravertebral procaine or alcohol block [6]; (3) sympathectomy [6,11] (White et al.), which can also be used postoperatively to increase exercise tolerance. Boyd [2] advocates simultaneous sympathectomy and endoaneurysmorrhaphy and has observed no gangrene (number of cases not listed). Elkin [3,4] lists 160 cases without gangrene in which no sympathectomy was performed.

The beneficial results of sympathetic block and sympathectomy are listed [6]: (1) overcome vasospasm in large vessels and vasa vasorum (break vicious cycle); (2) produce vasodilatation; (3) increase flow through capillaries, lymph vessels and main artery distal to ligation; (4) prevent ischemic gangrene; (5) decrease size and increase clotting of aneurysmal sac; (6) increase size and number of collaterals.

The Matas-Moschcowitz test can be used as an index of the efficacy of the foregoing measures. The extremity is elevated 30 degrees, the main artery compressed with fingers or the compressor just proximal to the injury. An Esmarch bandage is applied from the digits to the point of injury. Both are held for five minutes and the bandage is then removed. Ideally, the limb should flush to the digits in one minute, preferably in not more than three minutes. An inadequate response should encourage further delay before operation.

Transfusion before, during and after operation should be given as needed. Four to five pints ready in the operating room will protect the surgeon's coronary arteries in case of accident.

Preoperative percutaneous angiography should be considered if its performance will aid diagnosis, prevent error or in any way facilitate the procedure. However, the danger in an already precarious circulation should be weighed against the advantage to be gained.

Gangrene of the small toe has been reported [9] following postoperative angiography. Operative angiography is characterized [1] as extensive and traumatic. Our experience confirms this. A No. 25 gauge needle hole may require suture. Difficulty is encountered in dye flow with needles smaller than size 20. If angiography is done, it is wise to compress the main artery above, either manually or by tourniquet, and place a tourniquet below as well. Injection directly into the aneurysm is feasible.

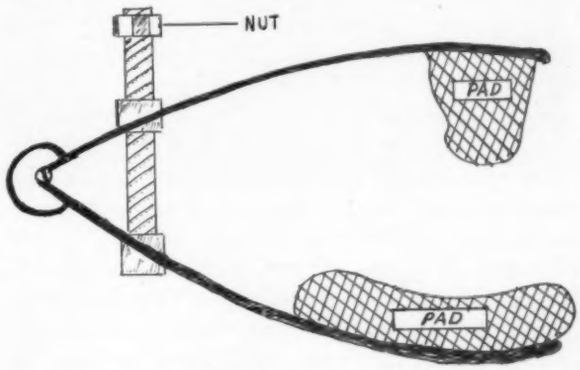


FIG. 2. Matas' arterial compressor.

Oscillometry or oscillographic tracings, the plethysmograph and skin temperature readings have been found worthwhile [6].

### OPERATIVE TECHNIC

Where possible, resection of the aneurysm with replacement by an arterial graft is the procedure of choice. Freeze-dried homografts have recently been reported satisfactory for peripheral arteries. The use of orlon or nylon prostheses for smaller arteries where much movement occurs is not as satisfactory as employment of homografts [22].

Pratt [16,17] has emphasized the feasibility of resection and end-to-end anastomosis of arteries, bridging gaps up to 4 to 5 cm. by release of the vessel from its bed and flexion of a nearby joint. Smilorylov [16,17] reported no gangrene after arterial suture as compared with 10 per cent after ligation. Continuity may also be restored by a vein graft [16,17]. Neither of these repairs should be done in the presence of calcification (Bigger [16]). This statement has been questioned by Humphries [23], who reports aortic grafting in the presence of calcification of the host aorta and states that it is possible to suture through calcific plaques and obtain healing.

When homografts are not available, the procedure of obliterative endoaneurysmorrhaphy described by Matas in 1888 is still worth considering. Details of technic can be found in any standard surgical work or may be seen graphi-

cally in the beautiful color photographs of Elkin [3].

Spinal anesthesia is advised [3,4]. The extremity should be emptied by use of an Esmarch bandage [3,4]. A tourniquet or temporary arterial occlusion as by bulldog clamp or catheter should be used if possible.

The artery and vein should be exposed above and below the aneurysm, and controlled before dissection of the sac is begun.

When excision of the sac does not endanger the main or collateral blood supply to the limb, it is wise to remove the sac and ligate the proximal and distal artery and any branches to the sac. Otherwise, Matas' obliterative or reconstructive procedure should be considered. One gains the opinion from the literature that Matas' reconstructive or reparative aneurysmorrhaphy is little used. In any case, as much of the sac as possible should be excised. A muscle transplant may help in obliterating sac space [16,17]. The importance of removing the pressure of the sac hematoma is emphasized.

Bleeding from the end of the artery distal to the sac (Coenen's test) helps measure collateral circulation. When tissue of questionable strength has been used in arterial reconstruction or when the aneurysm cannot be excised, the use of talc or cellophane will produce exuberant fibrosis.

Opinion of authorities does not settle the question of ligation of the concomitant vein. Those opposed to ligation [1] argue that the only aid secured is congestion of the capillary bed. They believe that placing the limb 4 to 6 inches below heart level produces the same effect, namely, to keep collateral blood supply in the tissues of the limb long enough for complete deoxygenation. Homans [1] agrees.

Tuffier [6,7] compared the results in popliteal artery ligation where gangrene occurred in 66 per cent of cases when the artery alone was ligated. With ligation of the popliteal vein the percentage was only 24.5. Heidrich [6,7] listed 995 peripheral artery ligations with gangrene occurring in 15.5 per cent; in 198 cases the accompanying vein was ligated and there was a rate of only 8.5 per cent gangrene.

The frequent occurrence [12] of thrombosis of the concomitant vein due to sac pressure, operative trauma, the previous injury and the like may tend to make this discussion academic.

Halsted [6] emphasized mistakes in management of aneurysms, as follows: (1) opening sac without controlling blood supply; (2) ligation of major artery as a precautionary measure in search for a distal bleeding point; (3) ligation of a trunk too far from the aneurysm; (4) packing the wound with gauze to control bleeding; (5) drainage; (6) use of catgut or too fine silk; (7) proximal ligation of the artery in arteriovenous aneurysm.

In considering the danger of arterial ligation [6], these figures are interesting:

| Procedure | Ischemic Gangrene (%) |
|---|---|
| Peripheral artery ligated for hemorrhage or trauma | 40–66 |
| Peripheral artery ligated for arterial aneurysm | 8–15 |
| Peripheral artery ligated for arteriovenous aneurysm | 5 |

In postoperative care the following should be emphasized:

I. Prevention of vasospasm (may negate a good collateral supply) by paravertebral block or autonomic blockade

II. Guarding of limb mortality and morbidity
   - A. Direct blood current selectivity toward threatened limb; keep 4 to 6 inches below heart level; a 45 degree elevation of the bed with patient flat and feet at lowest point has also been recommended
   - B. Reduce demand of starved tissues for oxygen to the lowest level compatible with survival
     1. Warm body (heat cradle to abdomen) and cool limb by exposure to room temperature or fan; cooling with ice seems unwise when one recalls the numerous thromboses above tourniquet level in limbs iced for amputation purposes; controlled cooling by refrigeration units similar to those of Smith and Fay have not been discussed in the references cited herein
   - C. The use of intravenous 2% NaCl [1] is mentioned; the rationale is not discussed
   - D. A non-constricting bandage should be used; splints or casts should be reserved for cases in which there are joint contractures and nerve injury repairs; dressing should be checked hourly

FIG. 3. Case 1. Preoperative photograph (close-up of thigh).

E. Blood restoration should proceed
F. Buerger's exercises, consisting of one minute of elevation, three minutes of dependency and return to postoperative position for three to five minutes, should be considered
G. Heat to the leg operated upon is never indicated
H. Drugs such as papaverine and alcohol are time-honored; papaverine may be given intravenously and has been injected into the main artery of the limb in ½ gr. doses every three or four hours; alcohol is given in ounce doses every two to three hours; pantopon® and atropine [*15*] have been recommended

Should sympathectomy, a paravertebral or stellate block be contraindicated, the use of total autonomic blocking agents by vein, muscle or mouth might be considered.

Priscoline® has been used by us with good results in arterial insufficiency. Bigger [*6*] has emphasized the likelihood of this complication.

### CASE REPORT

CASE 1. A thirty-five year old Negro man received a gunshot wound (32 caliber bullet) of the left thigh in April, 1950. In April, 1953, progressive swelling of the thigh developed. There was no pain, coldness, numbness of leg or weight loss. The history contained no other pertinent findings.

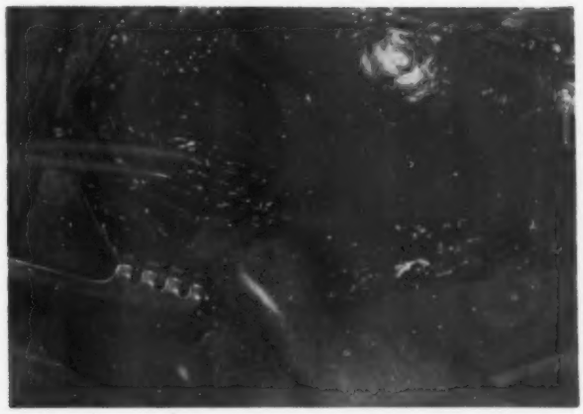

FIG. 4. Case 1. Operation; control of common femoral artery.

Positive physical findings were: a small umbilical hernia and a huge ovoid swelling of the left thigh medially (Fig. 3), which was movable but could be fixed by contracting the thigh muscles; it was pulsating synchronously with the pulse and was diminished by proximal arterial compression (common femoral). Popliteal, dorsal pedis and posterior tibial pulses were not obtained. There was no temperature, trophic, sensory or motor change in the thigh, leg or foot. Healed wounds of entrance and exit of the projectile were present on the medial and lateral thigh on the left, at the level of the femur. X-rays showed circular calcification near the femur and in the location of the aneurysm. An attempt was made to take an arteriogram during the operation but this was unsuccessful.

A preoperative diagnosis of aneurysm of the left femoral artery was made, and operation was performed on September 23, 1953.

The patient was placed in the dorsal decubitus position with his left leg abducted and extended. The affected area was prepared with pHisoderm®-ether-merthiolate,® including the abdomen and the entire leg and foot so that the foot might be inspected during the procedure. Under unilateral spinal plus sodium pentothal®-oxygen-curare anesthesia, a long diagonal incision was made from above the inguinal ligament on the left well down toward the adductor tubercle, passing directly over the central portion of a large ovoid mass in the thigh that measured approximately 20 by 10 by 10 cm. in size. Dissection was carried down to the common femoral artery in the upper thigh below the inguinal ligament and a soft rubber catheter was passed around the common

FIG. 5. Case 1. Further dissection of aneurysm.

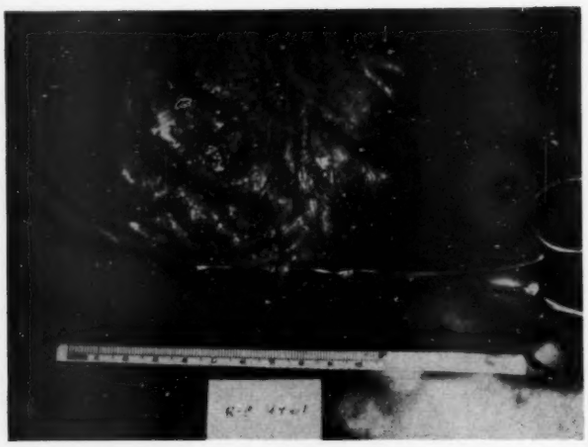

FIG. 6. Case 1. Aneurysmal sac removed.

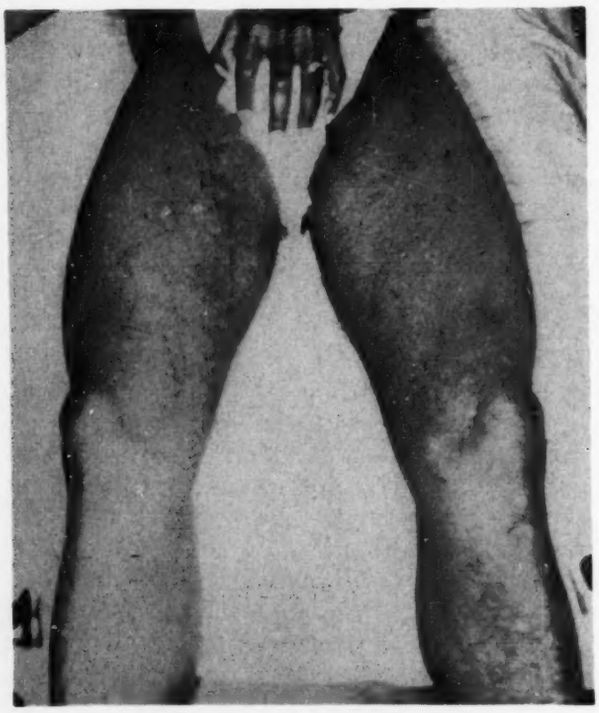

FIG. 7. Case 1. Photograph six months after operation.

femoral artery at this point for control (Fig 4). The superficial femoral artery was then exposed in Hunter's canal below the mass and likewise controlled. The femoral vein was identified and preserved at both points. It was believed at this time that the aneurysm arose from the superficial femoral artery. However, on freeing this aneurysmal mass and dissecting around it, it was apparent that it was completely free from the superficial femoral artery and arose from the profunda itself. (Fig 5.) It was believed that control of the common femoral artery was satisfactory for control of the profunda. However, as the aneurysm was dissected, it was obvious that this was not so and the collateral circulation which had been established was sufficient to give a good supply to the profunda branches by the crucial anastomosis around the hip joint.

Calcific plaques were present in the deep scar which had resulted from the gunshot wound (which was the cause of the aneurysm) and these plaques were so tough as to defy dissection with scissors; a sharp knife was required to get through them. In dissecting at this portion of the sac the profunda branch was entered and hemorrhage occurred which is best described as tremendous. This was controlled by finger and clamp. However, considerable blood was lost by the patient at this stage of the operation.

The trunk of the profunda was identified above and below, and controlled by free and suture ligatures at each site. The accompanying vein was also dealt with in the same manner.

The aneurysmal sac (Fig. 6) as removed, measured approximately 15 by 10 by 8 cm. in size and contained the usual amount of old blood clot plus the calcific scar as previously described. A second portion of calcific scar was excised from the upper end of the profunda, and the profunda religated at this point in the same manner.

The space left after removal of the aneurysmal sac was filled with two large pieces of gelfoam.® A smaller piece was placed next to the femur, where the calcific portion of the sac was attached.

Halsted's recommendation was disregarded and the area drained. This proved to be sound judgment.

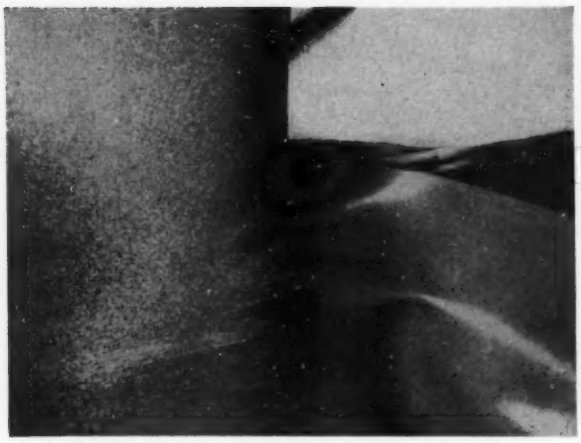

FIG. 8. Case II. Preoperative photograph.

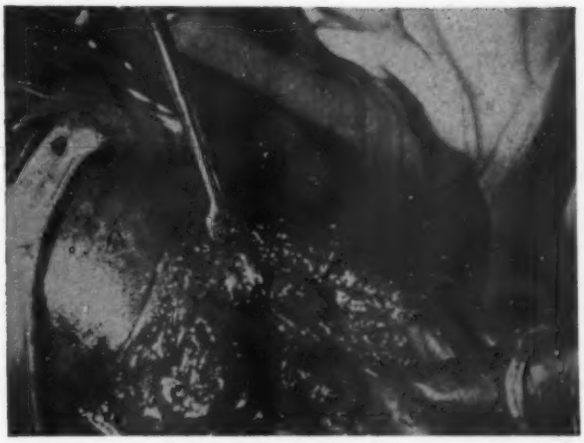

FIG. 9. Case II. Operative photograph showing open end of radial artery and false sac space.

Photographs were taken during the procedure. An attempt was made to take an arteriogram at the beginning when the common femoral artery was exposed. However, because of inadequate filling of the artery this was not satisfactory. The hole through which the No. 25 gauge needle was inserted into the artery bled freely after this and required closure with a single suture of No. 000000 wire.

The postoperative diagnosis was aneurysm of the left profunda femoris artery.

At his last visit on March 13, 1954, the patient showed excellent healing with full function of his leg. (Fig 7.)

CASE II. A twenty-one year old Negro man, a farmer, received a knife wound in the left antecubital space on March 20, 1953, during an altercation. The wound was 5 cm. long and 3 cm. deep and bled freely. Injury to the median nerve was suspected but findings were equivocal because the patient was intoxicated and in severe pain, and had worn a tourniquet above his elbow for more than two hours. Repair was accomplished in the emergency room and healing was uneventful.

On April 1st the patient noted a pulsating swelling of this same area and sought consultation.

He had nocturia, once per night; the history was otherwise insignificant. Physical examination gave the following positive findings: The tonsils were enlarged grade II. There was a pulsating, expansile mass 5 by 5 cm. over the left antecubital space, which was warm with surrounding redness. The left radial pulse was weaker than the right. The ulnar pulse was also weaker than the right. The patient could not extend his elbow because of pain, nor could he appose thumb to fingers or flex the index finger. His fist was weak. Sensation in the index finger, the middle finger and the radial half of the fourth finger was subnormal. Impressions were: (1) aneurysm of brachial, radial or ulnar artery near bifurcation (Fig. 8); (2) concomitant median nerve damage due to wound or pressure.

Operation was undertaken on April 6th, as the patient refused to wait for collateral circulation to improve (because of severe pain).

The patient was placed in the dorsal decubitus position with his left arm extended. The affected area was prepared with pHisoderm, ether and merthiolate, as was an area on the left side for possible vein grafting. With the patient under .5 per cent sodium pentothal-oxygen anesthesia, a curvilinear incision was made. The incision was begun on the upper lateral aspect of the arm just above the elbow crease, curving downward over the patient's previously repaired wound and then curving downward on the medial side of the forearm, the entire incision being approximately 15 cm. long. Flaps were dissected upward and downward, and the aneurysmal sac was exposed. Bleeding was controlled by a blood pressure cuff which had been sterilized and made a part of the operative procedure. The boundaries of the antecubital space were carefully defined, the pronator teres muscle on the ulnar side and the brachioradialis and biceps muscles on the radial side, and careful search was made for the brachial artery. This was not in its normal

FIG. 10. Case II. Postoperative scar.

position in relation to the biceps tendon in the antecubital space. It was placed much more medialward. The superior ulnar collateral vessels were quite large and had also been injured in the stabbing. These were dissected and carefully religated at a higher point. There were many superficial veins and these were ligated in the course of dissection. The brachial artery was finally exposed well toward the medial side of the wound and was found to be thrombosed for approximately 3 cm. of its length, apparently due to the trauma plus the pressure of the aneurysmal sac. The aneurysm had arisen from the radial branch of the brachial artery and the orifice opening into the aneurysmal sac was well defined and could easily be seen. (Fig. 9.) This branch was dissected up and then ligated with No. oooooo arterial wire and doubly ligated with a suture ligature. The accompanying veins were handled in the same manner. At this point circulation in the wrist was tested and found to be adequate, there being a palpable radial pulse. For this reason the portion of the thrombotic brachial artery was not excised and replaced by vein graft, it being thought that the collateral circulation was adequate for satisfactory survival of the arm.

The inferior portion of the wound was

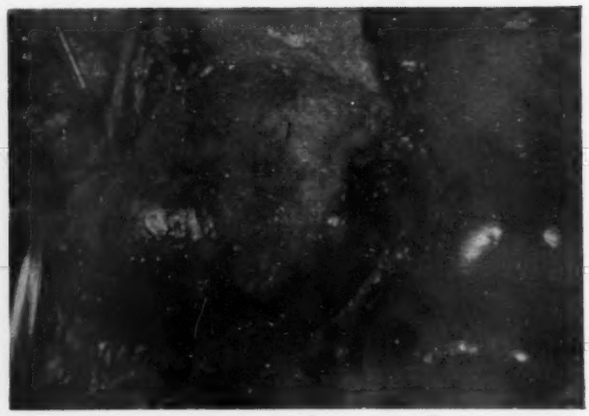

FIG. 11. Case IV. External iliac aneurysm. Deep circumflex iliac vessels are shown.

searched, and arterial and venous branches at this point were secured and ligated. A piece of gelfoam was packed into the space, which was approximately 3 by 4 by 5 cm. in size. An attempt was made to close it partially by suturing the pronator teres to the brachioradialis muscle. The median nerve was carefully inspected and found intact. It is believed that the median nerve palsy which this patient had was due to pressure from the aneurysm rather than actual injury in division.

The subcutaneous tissues were approximated with interrupted No. ooo chromic catgut and the skin with interrupted sutures of No. ooo nylon. A plaster splint was applied as well as a mild pressure dressing using Ace bandage over the plaster splint.

The postoperative diagnosis was aneurysm of the left radial artery.

The patient was discharged on the fifth postoperative day with early evidence of returning function of the median nerve.

On May 28th healing was excellent, with full return of function of the elbow and thumb. Grade II weakness of the index finger and impairment of sensation persisted as before. Corrective exercises were recommended. The patient failed to return for further examination. (Fig. 10.)

CASE III. A thirty-nine year old Negro man was sprayed with shotgun pellets on July 5, 1953. He made an uneventful recovery except for hemarthrosis of the left knee joint, which responded well to tap and injection of penicillin. Injury to the lower femoral vessels was feared but did not occur. Two hematomas anterior to the left tibia continued to drain, but the re-

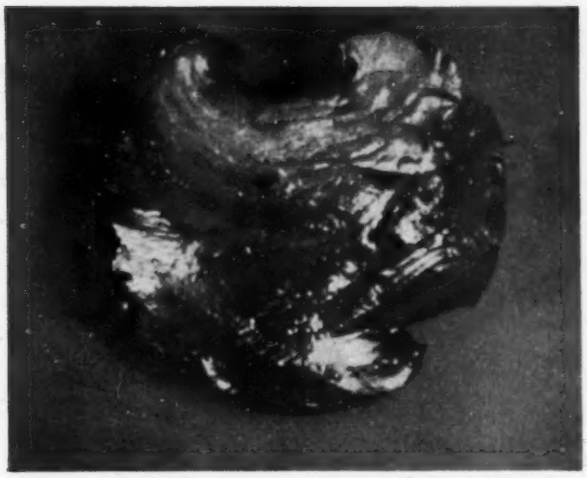

FIG. 12. Case IV. Laminated aneurysmal clot showing attempt to restore normal vessel caliber; cross section.

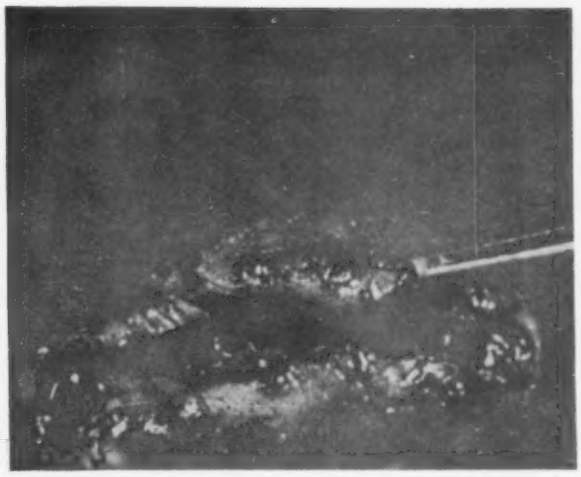

FIG. 13. CASE IV. Aneurysmal clot; longitudinal view.

maining wounds of the leg and thigh healed uneventfully. The upper left tibial hematoma improved, but the lower one became redder, more tense and sore. Pulsation was not elicited. This was due to tenseness of the tissues and clot.

X-ray examination on September 8th revealed the following: Re-examination of the left lower leg in comparison with previous films showed a marked increase in the amount of cortical resorption in the anterior portion of the mid-shaft of the tibia, with definite periosteal reaction and the detachment of a small fragment of bone into the soft tissues in this area. Soft tissue swelling appeared to be somewhat greater than at the previous time. This had the appearance of osteomyelitis secondary to soft tissue infection. The numerous fragments of lead shot were again noted and were essentially unchanged in appearance.

Other pertinent findings in history were nocturia, once nightly, and infection of teeth. Pertinent physical findings were: (1) marked dental caries, tartar and periodontoclasia; (2) multiple shotgun wounds of both legs and thighs; (3) effusion of left knee joint (hemarthrosis), edema and hematomas of both lower legs; (4) old scar (childhood burn) 6 by 11 cm. present on the right tibia.

Operation was undertaken on September 9th, a curettage of an old abscess cavity being anticipated because of the preoperative diagnosis of possible osteomyelitis of the left tibia.

The patient was placed in the dorsal decubitus position and the affected area prepared with pHisoderm, ether and merthiolate. Under sodium pentothal-cyclopropane-oxygen anesthesia the two draining sinus tracts were circumscribed and connected with a transverse incision. On dissecting downward, a large amount of old black clot was entered, following which profuse hemorrhage occurred. Because it was apparent that the hemorrhage was of an arterial nature, the cavity was packed, a tourniquet was applied to the leg and incision was extended upward and downward for a total distance of approximately 14 cm.; the flaps were reflected lateralward, the aneurysm cavity was evacuated and the bleeding vessel was exposed. This proved to be the anterior tibial artery. The peroneal nerve was not disturbed at any time. The artery was freed from its base of fibrous tissue and the clot above and below the site of injury, and was ligated above and below with ligatures of No. 00 cotton. It was believed that any attempt to repair this vessel in its present state would be fraught with disaster, and it was also thought that this patient had had sufficient time to establish a collateral circulation so that ligation of this vessel would do his leg no harm. Following this the tourniquet was released and the bleeding points were ligated.

The wound was closed by approximating the muscle and subcutaneous tissues with interrupted sutures of No. 0 chromic catgut, the skin with interrupted sutures of No. 000 nylon. The hematoma cavity above and below the transverse limit of the incision was packed with strips of furacin® gauze.

The postoperative diagnosis was traumatic aneurysm of the left anterior tibial artery.

The patient tolerated the procedure well and recovery was uneventful.

CASE IV. This case is one of an aneurysm of the external iliac artery (Fig. 11), seen during precepteeship training, the aneurysm occurring at the distal end of a vessel ligated nearly twenty years before for multiple traumatic arteriovenous fistulas following a pistol wound. Photographs of the opened aneurysm showed clot lamination and an attempt to restore normal vessel caliber. (Figs. 12 and 13.)


## SUMMARY

A discussion of the pathogenesis, diagnosis, preoperative preparation, surgical treatment and postoperative care of the patient suffering from a traumatic aneurysm of the peripheral arteries has been presented, with three illustrative cases.


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# Non-parasitic Splenic Cysts

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SPLENIC cysts are considered rare lesions. Cystic changes in the spleen occur less frequently than cystic disease of any other abdominal viscera. In 1829 Andral [*1b*] described the first splenic cysts at autopsy. The first successful removal of a splenic cyst was performed by Pean in 1867 [*2*]. Kirby [*1a*] reported 188 cases of non-parasitic cysts of the spleen. This entity is one which is easily overlooked because of the misleading symptomatology, the lack of definitive localizing signs, and the inability to find the mass on physical examination.

## INCIDENCE

Pemberton [*3*] reported 800 splenectomies with four cases (or 0.5 per cent) of cyst formation. Kirby [*1a*], in 1955, reported 188 cases of non-parasitic cysts of the spleen. In the period 1904 to 1940 there were eight cases in the records of the Pathology Department at Bellevue Hospital in New York [*4*]. In the period 1904 to 1934 the Mayo Clinic reported 646 splenectomies with only two cases of splenic cysts [*5*]. Martin et al. [*6*] reported thirty calcified cysts of the spleen in 1950.

Splenic cysts occur most frequently in the age group of twenty to fifty years. They are more commonly seen in females than in males [*7*], and are occasionally found in children.

## ETIOLOGY AND PATHOLOGY

The etiology of the non-parasitic splenic cyst has not been definitely described. Although trauma has been suspected of playing an important role in the formation of the large hemorrhagic or serous type of splenic cyst, not all cases have a history of previous injury [*6–8*]. (Table 1.) Also, the reliability of the history of trauma can be open to question, for at some time in the past almost everyone has sustained some type of injury to the chest or abdomen. When trauma [*6*] is suspected as being the etiologic agent the sequence of events is thought to be the following: injury, splenic laceration within the capsule, laceration of splenic vessels, hemorrhage, encapsulation of the hematoma, absorption of the blood, fibrous wall formation and persistence of serous fluid.

TABLE 1
ETIOLOGY OF SPLENIC CYSTS

1. Trauma
2. Spontaneous intrasplenic hemorrhage with organization
3. Menstruation
4. Pregnancy
5. Infarction of spleen
6. Splenomegaly due to other diseases
7. Occlusion of vessels:
   - Thrombosis
   - Embolism
   - Endarteritis
8. Peritoneal infoliation cysts
9. Congenital cellular rests
10. Unknown
11. Malaria

Spontaneous intrasplenic hemorrhage has also been incriminated as a possible etiologic agent.

Another possible etiologic factor considered has been menstruation and the role of pregnancy [*9*]. The basis for this has been the fact that splenic cysts occur more frequently in women than in men, and most frequently in the child-bearing age. Often there is a menstrual irregularity reported in cases of splenic cysts. It is also known that the spleen becomes congested during menstruation and pregnancy. There is a report of a case of a marsupialized splenic cyst which continued to discharge blood

at the time of each menstrual period [9]. Aiengar [10] reports that 70 per cent of the cases of splenic cyst occurred during pregnancy, and 20 per cent of these give a history of trauma.

Another etiologic factor has been splenic infarction with degeneration of the arteriolar blood supply to a portion of the spleen [11]. Experimental work has been reported in the literature to support and dispute this theory [6].

Another possible etiologic agent is splenomegaly due to other diseases of the spleen (malaria, syphilis, typhoid fever, paratyphoid fever, mumps). With splenomegaly the patient is somewhat more likely to have injury to the spleen if subjected to trauma.

Another possible etiologic agent is the possibility of peritoneal infoldings with subsequent trauma, thus producing what has been known as infoliation cysts. Also, congenital cellular rests in the spleen with subsequent growth, with or without trauma, have been given as explanations for the development of splenic cysts [6,12,13].

Thrombosis, embolism and endarteritis have been suggested as the bases of the development of cysts secondary to degeneration of the splenic tissue following the closure of the vessels [9].

Calcification of splenic cysts can occur regardless of the etiologic agent. This has been reported in parasitic cysts [6,14,15].

TABLE II
SPLENIC CYST CLASSIFICATION*

I. Primary true cysts
  A. Congenital
    1. Infoliation cyst
    2. Dilatation or ectatic cysts
  B. Traumatic
    1. Infoliation cysts
    2. Dilatation or ectatic cysts
  C. Inflammatory
    1. Infoliation cyst
    2. Dilatation or ectatic cysts
  D. Neoplastic cysts
    1. Dermoid
    2. Epidermoid
    3. Lymphangioma
    4. Cavernous angioma
  E. Parasitic
    1. Ecchinoccus
II. Secondary or false cysts (possessing no true epithelial lining)
  A. Trauma
  B. Inflammation
    1. Tuberculosis, perisplenitis, etc.
  C. Degeneration
    1. Infarcted secondary to thrombosis, embolism, endarteritis, ruptured aneurysm, etc.

* From FOWLER, R. H. [13].

## CLASSIFICATION

Fowler's system of classification of splenic cysts is the one most frequently quoted [13,16]. (Table II.)

Strode attempted to classify splenic cysts by their location [17]. He found that 26 per cent of them were located in the lower pole, 18 per cent on the convex surface of the spleen, 18 per cent on the concave surface of the spleen, 14 per cent at the hilus, 12 per cent at the anterior border of the spleen, 9 per cent at the upper pole and 3 per cent on the posterior border.

## SYMPTOMATOLOGY

Splenic cysts may be asymptomatic. The finding of the splenic cyst may be accidental on a routine physical examination, at exploratory laparotomy or abdominal operation for other disorders, or during gastrointestinal x-ray studies [1–3,6,8,18–20]. (Tables III and IV.)

Symptoms may be produced by the mass within the abdominal cavity. There may be heaviness in the left upper quadrant and left hypochondrium. There is also a possibility of pain associated with the presence of this mass. The pain has been reported as being in the abdomen, the chest, the left shoulder, the left hypochondrium, the epigastrium, the midback, the periumbilical region, the left costovertebral angle, and the left chest. The pain seems to be aggravated following large meals.

The symptoms may be secondary to pressure. Pressure upon the cardiopulmonary system may produce dyspnea, cough or chest pain. It is believed that this group of symptoms is produced primarily by an upper pole cyst. The gastrointestinal system yields the following symptoms: vague digestive disturbances, nausea, vomiting, fulness, constipation, flatulence, abdominal pain and diarrhea. The genitourinary system has not been incriminated in terms of specific symptoms but in the case reported herein the patient exhibited difficulty in voiding which consisted of burning and some pain. There had also been albuminuria. This cleared prior to operation.

A temperature elevation and weight loss may be associated with the presence of splenic cysts.

Several changes have been reported on the basis of x-rays which may help in making the diagnosis of splenic cysts. A plain plate of the abdomen may reveal a soft tissue mass in the left upper quadrant which moves with respiration. There may be obliteration of the psoas shadow. Fluoroscopy of the diaphragm may reveal elevation of the left side and limitation of excursion. The chest x-ray may demonstrate pleural effusion and pneumonitis. An intravenous pyelogram may show displacement of the left kidney downward. The gastrointestinal series may reveal that the stomach is displaced downward and to the right as is the jejunum and the ileum. The splenic flexure is displaced downward. Usually splenomegaly due to other causes does not displace the splenic flexure.

Physical examination may reveal no abnormalities. However, a mass may be palpable in the left upper quadrant of the abdomen. There may be bulging of the left lower intercostal spaces. The diaphragm may exhibit impaired motion and elevation. Percussion and auscultation of the chest may reveal secondary pulmonary findings. Pneumoperitoneum, followed by x-ray has been reported as an aid in the diagnosis of splenic cysts. Splenoportography may also help.

TABLE III
SYMPTOMATOLOGY

I. Accidental discovery on physical examination, at operation or by x-ray studies
II. Space occupation
  A. Heaviness in left hypochondrium
  B. Pain
    1. Abdomen
    2. Chest
    3. Left shoulder
    4. Left hypochondrium
    5. Epigastrium
    6. Mid-back
    7. Umbilical
    8. Left costovertebral angle
    9. Left chest (after large meals)
III. Pressure symptoms
  A. Cardiopulmonary system
    1. Dyspnea
    2. Cough
    3. Pain
  B. Gastrointestinal symptoms
    1. Vague digestive disturbances
    2. Nausea
    3. Vomiting
    4. Fulness
    5. Constipation
    6. Flatulence
    7. Diarrhea
    8. Abdominal pain
  C. Genitourinary symptoms
    1. Dysuria
    2. Albuminuria
IV. Temperature elevation
V. Weight loss

TABLE IV
ROENTGENOGRAPHIC DIAGNOSIS

1. Left lower lobe pneumonitis
2. Left pleural effusion
3. Elevation of diaphragm
4. Limitation of excursion of diaphragm
5. Soft tissue mass, moving with respiration
6. Obliteration of psoas shadow
7. Displacement downward and to the right of the stomach, jejunum and ileum
8. Splenic flexure displaced downward
9. Left kidney displaced downward
10. Pneumoperitoneum
11. Splenoportography

## DIFFERENTIAL DIAGNOSIS

Table v lists the diseases most frequently confused with splenic cysts [2,3,6,8,14,21,22].

TABLE V
DIFFERENTIAL DIAGNOSIS

1. Pancreatic cyst
2. Omental cyst
3. Mesenteric cyst
4. Cyst of left lobe of liver
5. Ovarian cyst
6. Cyst of left kidney
7. Splenomegaly due to other causes
8. Echinococcus cyst
9. Tumor of left kidney
10. Aneurysm of splenic artery
11. Retroperitoneal tumor

The difficulty of differentiating an echinococcus cyst from other types of cysts of the spleen may be overcome by the use of the various diagnostic skin and antigen tests. If the splenic cyst is calcified, the differential diagnosis of an aneurysm of the splenic artery must be considered. The aneurysm will reveal a bruit, expansion with pulsation and an interrupted calcification, as against a continuous calcified layer seen in a cyst. Retroperitoneal tumors are ruled out when the colon is pushed downward rather than forward. Splenomegaly, which

FIG. 1. Plain plate of the left upper quadrant, revealing a large soft tissue mass (recumbent film).

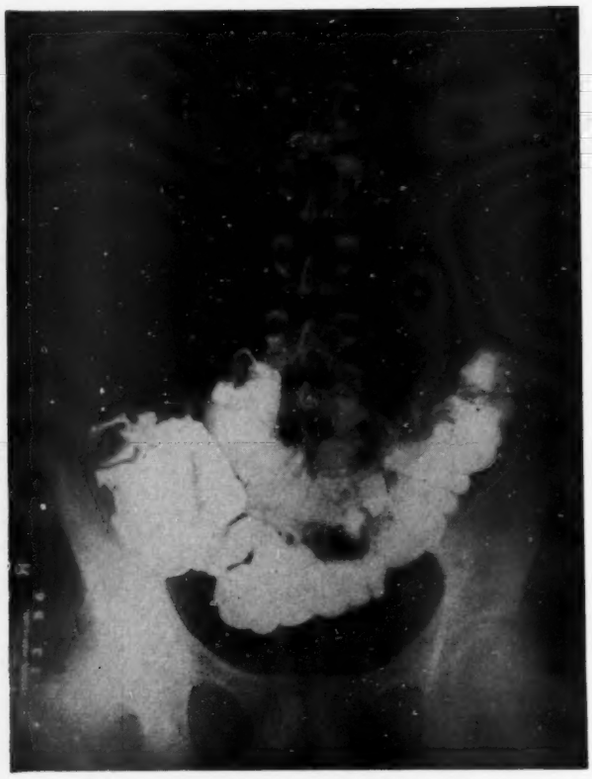

FIG. 2. Three-hour film after gastrointestinal series, revealing displacement of the jejunum downward and to the right, and displacement of the colon downward by a soft tissue mass (recumbent film).

is the result of causes other than a splenic cyst, will not usually result in a depression of the splenic flexure of the colon.

### TREATMENT

Early reports of the handling of splenic cysts described marsupialization as a recommended procedure. However, with the improvement in modern surgery and the adjunct measures now available, splenectomy is considered the method of choice. There have been many articles written on the technic of splenectomy, the types of incision used and the advisability of the complete removal of the spleen. I believe that the thoracoabdominal incision is the most desirable one if the diagnosis has been made preoperatively. If, however, it has not been made preoperatively and abdominal laparotomy has been performed, the incision should be extended to make a thoracoabdominal (combined) type. I also believe that the splenic bed should be drained and that prophylactic anticoagulant therapy should be instituted postoperatively to prevent the possibly fatal complication of thrombosis of the splenic vein and subsequent thrombosis of the portal vein.

The results of treatment with splenectomy are excellent. There is a complete cure following splenectomy and removal of the splenic cyst. The mortality rate for splenectomy has been reduced markedly in recent years. If only elective cases are considered, the mortality rate is not much greater than that for routine laparotomy.

### CASE REPORT

This sixteen year old white boy was given a physical examination by the Navy. Urinalysis revealed albuminuria for which he was referred to his physician, who found a mass in the left upper quadrant of the abdomen. The patient was admitted to the hospital where close questioning revealed the possibility of trauma approximately thirteen years previously. The patient remembers that at that time he sustained an injury to the left side which produced a scar in the left flank at the time of injury. Family history was non-contributory.

The patient gave a history of some vague

periumbilical fulness with meals but no pain. He denied nausea, vomiting or diarrhea. There had been a long problem of irregularity of bowel movements and constipation. The patient also complained of some burning pain on urination.

Physical examination was completely normal except for the following positive points: a mass was present in the left upper quadrant of the abdomen, extending out from beneath the left costal margin, beginning at a point approximately in the anterior axillary line and extending almost to the lateral border of the left rectus muscle. This mass extended approximately three fingerbreadths below the level of the costal margin and moved with respirations. The mass was also slightly tender to deep palpation. When the patient turned on his right side, the mass appeared to move toward the midline.

A flat plate of the abdomen revealed a soft tissue mass in the left flank. Cystoscopy and retrograde pyelography revealed no abnormalities. Chest x-ray examination was negative. The gastrointestinal series revealed an ovoid, soft tissue mass measuring approximately 12 cm. in diameter (on the x-ray film) and situated in the left flank. (Figs. 1 and 2.) There was evidence of extrinsic pressure on the proximal loops of the jejunum, with deviation of the jejunum toward the midline and depression downward. The following studies were within normal limits: electrocardiographic, serologic test for syphilis, blood urea, blood sugar, prothrombin activity, hematocrit, white blood cell count, differential count and cell indices.

On February 16, 1956, the patient was taken to the operating room where a preoperative diagnosis of ectopic spleen with torsion of the pedicle was made. The formerly easily palpable mass could not be felt, even under anaesthesia. The patient was a short, obese boy, and this hindered palpation. Consequently, a left subcostal type of incision was made and later extended up along the tenth intercostal space. On opening the peritoneal cavity, a mass 10 to 11 cm. in diameter was seen. This was thin-walled and distended with fluid (which subsequently proved to be dark brown in color and negative on culture). The mass was attached to the lower end of the spleen by a bridge of splenic tissue measuring approximately 4 cm. in diameter. Adhesions between this mass and the posterior aspect of the left omentum and

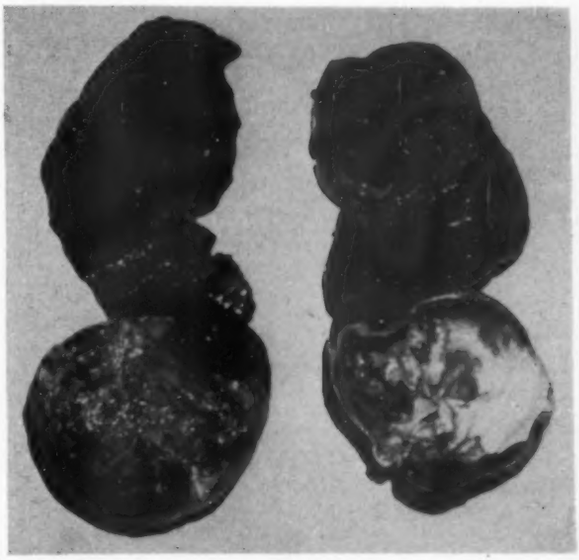

FIG. 3. Photograph of specimen removed and bisected. The cyst is attached by a short broad pedicle to the spleen.

transverse mesocolon were situated in such a way as to depress the entire transverse mesocolon while allowing the colon to ride above or cephalad to the mass. The transverse mesocolon was adherent to the mass and the middle colic vessels had to be peeled off the tumor mass itself. Stomach and omentum were adherent to the mass. The omentum and mesocolon overlay the mass and occupied the space between the mass and the anterior abdominal wall. The remainder of the exploration of the abdomen revealed no abnormalities. By careful dissection the middle colic vessels were dissected off the mass, and the mass and the spleen were removed. The wound was closed in layers. Rubber tissue drains were used to drain the splenic bed.

The patient's postoperative course was uneventful. There was a slight leukocytosis to 38,000, but this fell to 13,000 by the time of discharge. The hematocrit rose to 52, but fell to 46 by the time of discharge. The platelet count postoperatively rose from 120,000 to 380,000. The patient was given prophylactic anticoagulant therapy. On the seventh postoperative day, he complained of slight epigastric distress, associated with belching. This disappeared in a few hours and did not occur again. The patient was discharged nine days postoperatively and anticoagulant therapy was discontinued at that time.

The spleen and splenic cyst were described

FIG. 4. Photomicrograph at the junction of the spleen and the cyst. At the top of the photograph splenic pulp can be seen. At the lower half of the photograph thrombus and recent hemorrhage are shown. Between these two areas there is a thick fibrous capsule.

as follows: At the lower medial pole of the spleen there was a 10 by 8 by 5 cm. diameter cystic mass attached by a short broad pedicle, measuring 3.5 by 1 cm. (Fig. 3.) Together the cyst and spleen weighed 556 gm. Gross examination of the spleen and cyst revealed no specific abnormalities. The external surface of the cyst presented a variegated appearance. Microscopic examination revealed a normal spleen containing a large pseudocyst at its lower pole. (Fig. 4.)

The patient was re-examined approximately six months postoperatively and was found to be asymptomatic.

## SUMMARY

1. Non-parasitic splenic cysts are discussed, with a review of the incidence, etiology, pathology, classification, symptomatology, diagnosis and treatment.

2. A case of a non-parasitic cyst of the spleen is presented.

*Acknowledgment:* Pathologic report and photographs are through the courtesy of Dr. Tobias Weinberg, Director of Laboratories and Pathologist in Chief, Sinai Hospital, Baltimore, Maryland.

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# Intestinal Obstruction Due to Incarcerated External Hernia

## WITH NOTES ON NON-OPERATIVE REDUCTION AND INTERIM ELECTIVE HERNIORRHAPHY

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HERNIA has been a problem for ages, and is today a continuing source of morbidity and mortality. At the Milwaukee County Hospital between 1946 and 1956, 3,676 patients with external abdominal hernias were seen. Of these, 245 were incarcerated and as such represented the single most important cause of intestinal obstruction. The present study is an analysis of these cases.

A hernia is "the protrusion of a viscus from its normal cavity through a congenital or acquired aperture" [9]. Topographic designations (inguinal, femoral, umbilical) refer to the regional location of the aperture; the viscus concerned is almost always small bowel. It is not hernias *per se* which jeopardize life, but their complications. In an "irreducible" hernia the visceral contents cannot be replaced into the abdominal cavity; the patient may or may not have distressing symptoms. Irreducibility is due to chronic inflammatory changes and adhesions between sac and involved intestines. The term "incarcerated" hernia denotes an acute trapping of bowel with obstruction of the lumen impending if not existent. At first this is simple mechanical obstruction, but unless the hernia is reduced (spontaneously, manually or operatively) vascular compression produces strangulation and eventually gangrene.

In the natural history of a hernia, the patient's tissues encircling the aperture deteriorate, adhesions form, more bowel may be drawn into the hernia sac, and irreducibility, incarceration or strangulation supervene. Do all external hernias behave in similar fashion? Which hernias incarcerate? What of taxis or manual reduction? How many incarcerated hernias present simple obstruction, strangulation but no gangrene or gangrene? What operative measures are of best avail?

### ANALYSIS OF CLINICAL MATERIAL

With these questions in mind, the material at Milwaukee County Hospital over a recent ten-year period was studied. We were interested in determining whether manual reduction, as is effectively used in inguinal incarcerations of infancy, was a safe adjunct to operative measures in other types of hernia and in patients of all ages. Only cases with actual intestinal obstruction were studied, proved either at operation or by unequivocal clinical or x-ray findings. We were not concerned with the asymptomatic irreducible hernias and cases in which omentum only was caught in the hernia sacs.

Table 1 shows the over-all incidence of hernial obstruction. Only 5.4 per cent of inguinal hernias presented as incarcerations, but this defect is so common that they make up the majority of the cases under discussion. There were forty-six manual reductions in the 140 inguinal incarcerations, forty-two of them successful. Of the ninety-seven operated cases, thirty-seven showed simple obstruction only. Fourteen (15 per cent) had frank gangrene. The over-all mortality rate in inguinal incar-

TABLE 1
INCIDENCE OF ACUTE INTESTINAL OBSTRUCTION IN EXTERNAL HERNIAS

| Type of Hernia | Incidence | | Treatment | | | Type of Obstruction | | | Results | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total No. | Incarcerated | Non-surgical (taxis) | Surgical | None | Simple Obstruction | Strangulated but Viable | Strangulated and Gangrenous | Deaths | Mortality (%) |
| Inguinal | 2,568 | 140 (5.4%) | 42 (30%) | 97 | 1 | 37 | 47 | 14 (15%) | 17 | 12 |
| Femoral | 133 | 47 (30%) | 6 (13%) | 38 | 3 | 8 | 19 | 14 (34%) | 6 | 13 |
| Umbilical | 388 | 32 (8%) | 5 (16%) | 25 | 2 | 10 | 11 | 6 (22%) | 7 | 22 |
| Incisional | 547 | 17 (3%) | 2 (12%) | 14 | 1 | 8 | 0 | 7 (47%) | 6 | 35 |
| Epigastric | 30 | 2 (7%) | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Obturator | 3 | 3 (100%) | 0 | 2 | 1 | 0 | 2 | 1 | 1 | 33 |
| Semilunar (spigelian) | 6 | 2 (33%) | 0 | 2 | 0 | 1 | 1 | 0 | 1 | 50 |
| Interstitial | ... | 2 | 0 | 2 | 0 | 1 | 1 | 0 | 2 | 100 |
| Totals | 3,675 | 245 | 56 | 181 | 8* | 65 | 82 | 42 | 40 | 16 |

* Includes two cases found at autopsy, and six patients considered moribund on admission.

cerations was 12 per cent. It should be noted that one patient died of this disorder with the diagnosis revealed only at autopsy.

Forty-seven of 133 femoral hernias (30 per cent) were incarcerated, with six successfully reduced manually. Three patients were judged "not in shape for surgery," and died. In spite of the smaller number of femoral incarcerations there were just as many gangrenous (fourteen) as in the inguinal group. The mortality rate in the cases of femoral hernia incarceration was 13 per cent.

Eight per cent of umbilical hernias contained trapped bowel (omental incarcerations were excluded from the study). Table 1 lists the number reduced by taxis (five) and those operated (twenty-five). There were seven deaths, a mortality rate of 22 per cent.

Incisional hernias, although rarely incarcerated (3 per cent) were extremely dangerous. Only two of the seventeen cases could be manually reduced. Operations were difficult and the mortality rate was high (35 per cent).

The experience with the rarer types of hernia are listed in Table 1. Obturator hernias are technically external, but share the difficulty in diagnosis of an internal hernia. None of our three cases was diagnosed preoperatively. Two of these patients had positive Howship-Romberg signs (pain down the medial aspect of the thigh over the distribution of the obturator nerve), but the significance of the symptom was not appreciated. Another finding of significance is said to be the presence of a tender mass felt on rectal or vaginal examination laterally below the superior ramus; this sign was not noted in any of our cases.

Of the 189 operated or autopsied cases, 184 hernias contained small bowel, three held large bowel and two produced a mixed type of obstruction. In the operative inguinal group, ninety-two were indirect and six direct (eight were recurrent). There were five Richter's hernias (four femoral and one obturator) and one Littre's hernia, an incarcerated Meckel's diverticulum. This was a fifty-nine-year old woman with an indirect inguinal hernia, the diverticulum was gangrenous and was successfully resected.

Ninety-two per cent of the inguinal hernias were in males. Females predominated in the femoral (77 per cent) and umbilical (86 per cent) groups. In the operated cases there were only four patients under the age of two and one in the two- to 12-year age group. The oldest patient was a ninety-year old woman with a gangrenous femoral incarceration which was successfully resected. She survived to return at the age of ninety-two with a massive hemorrhage from a duodenal ulcer. Emergency gastric resection was performed and she again made an uneventful recovery.

### TAXIS OR MANUAL REDUCTION

There were sixty manual reductions, four requiring subsequent emergency surgery (two of these were hernial reincarcerations successfully operated upon). Another patient complained of persistent lower abdominal pain after reduction; operation revealed a segment of traumatized but viable ileum. In the fourth case a reduction *en masse* went unrecognized too long and operation was to no avail; this was the only death in the manual reduction group, and it was clearly preventable.

The procedures used in taxis reduction consisted of elevating the foot of the bed and administering a narcotic (morphine or demerol®) in judicious dosage. The traditional ice bag was frequently applied. After the narcotic had allayed pain, apprehension and spasm, gentle manipulation with diffuse pressure on the hernial mass was begun. A certain amount of patience and persistence is justified. The patient himself can be asked to attempt reduction. Disappearance of the hernial mass, immediate relief of pain and subsidence of the symptoms of intestinal obstruction signal a successful reduction. It is incumbent on the surgeon thereafter to make careful repeated checks to be sure that reduction has been accomplished. Early elective herniorrhaphy should be expeditiously arranged, if possible within a few days. The patient may be more willing at this time for elective repair.

Manual reduction was not attempted in exquisitely tender henias, and seldom in those incarcerated more than twenty-four to thirty-six hours. It is the belief at this institution that narcotics in moderate dosage do not mask symptoms and signs of actual strangulation. Our patient who underwent reduction *en masse* was operated upon too late because of an error in judgment; the patient's symptoms had not been relieved, a "fullness" was described as palpable deep to the internal ring, but operation was not undertaken for eighteen hours. Gangrene and peritonitis were encountered, necessitating resection, and the patient died.

### SIMPLE INCARCERATIONS WITHOUT STRANGULATION

Sixty-five of the 181 patients submitted to operation had simple obstructions. Four of these were associated with perforation, even though no strangulation was evident. One perforation occurred when a toothpick punctured small bowel contained in an umbilical hernia. Another patient whose entire right colon was contained in an incisional hernia had acute diverticulitis of the cecum with perforation. The two other perforations were spontaneous. Actually, these cases might be considered as irreducible (but not incarcerated) hernias which presented as acute emergencies due to fortuitous perforation of contained intestinal segments. It is noteworthy that perforation and peritonitis can occur in the absence of strangulation and gangrene. None of these patients with perforation had been submitted to taxis.

Treatment of these simple incarcerations consisted of reduction and immediate hernia repair in most cases, with closure of the perforations as indicated.

That the presence of an external hernia can be misleading is evidenced by the fact that one patient (not in this series) with an umbilical omental "incarceration" failed to improve after operative reduction and eventually died of peritonitis. Autopsy revealed a perforated sigmoid diverticulitis.

Table v lists the causes of death. There were eight operative fatalities in the simple incarceration group, all in patients over seventy (mortality rate of 12 per cent).

### EARLY STRANGULATIONS (STRANGULATED BUT VIABLE)

Vascular compromise was evident in 116 operative cases, but after release of the constriction the contents appeared viable in eighty-two. Surgical treatment usually included hernia repair, but in some poor risk patients the aperture was simply enlarged and no attempt at repair was made. There were fourteen deaths in this group, for a mortality rate of 17 per cent. (Tables II and V.) In no instance was it established that non-viable bowel had been replaced. However, one patient died of persistent intestinal obstruction from an overlooked constricting band elsewhere in the abdomen.

### STRANGULATED AND GANGRENOUS OBSTRUCTIONS

Thirty-four operative cases had gangrenous bowel in the hernia sac; of these, ten died (30 per cent mortality rate). Surgical management varied. Twenty-five patients were treated by resection and primary anastomosis, with six

deaths (mortality rate of 24 per cent). Three of these patients undergoing resection had concomitant drainage of the abdominal wall or scrotal abscesses secondary to gangrene and perforation. Two patients had successful plications of small gangrenous patches. Two very ill patients had exteriorizations; both died. Five additional patients underwent incision and drainage only for walled-off scrotal or abdominal wall abscesses.

Six patients were considered "not in shape for surgery"; actually two lived three days and one for eleven days. One suspects a less defeatist attitude could have been adopted. All of these cases fall into the "strangulated and gangrenous" group; however, it is entirely possible that bowel was still viable when the decision was made that surgery would not be attempted.

Two cases were undiagnosed until autopsy disclosed gangrene and peritonitis, one in an obturator hernia and another in an undetected inguinal hernia in a woman.

TABLE II
RESULTS OF TREATMENT OF INCARCERATED EXTERNAL HERNIA

| Treatment | No. of Cases | Deaths | Mortality (%) |
|---|---|---|---|
| Non-surgical: | | | |
| Successful taxis reduction | 56 | 0 | 2 |
| Exploration after reduction | 4 | 1 | |
| Surgical:* | | | |
| Simple incarcerations | 65 | 8 | 12 |
| Strangulation: | | | |
| Contents viable | 82 | 14 | 17 |
| Contents gangrenous:† | | | |
| Resection | 25 | 6 | 24 |
| Plication | 2 | 0 | 0 |
| Exteriorization | 2 | 2 | 100 |
| Incision and drainage of abscess | 5 | 2 | 40 |
| No treatment (all gangrenous): | | | |
| "Not in shape" | 6 | 6 | 100 |
| Found at autopsy | 2 | 2 | |
| Totals | 245 | 40 | 16 |

* Includes the four cases of exploration after reduction.

† Includes the death of one of the four patients explored after reduction.

TABLE III
AGE FACTOR IN OPERATIVE MORTALITY OF INCARCERATED EXTERNAL HERNIA

| Age Range | No. of Patients | Deaths | Mortality (%) |
|---|---|---|---|
| 0–40 | 19 | 1 | 5 |
| 40–60 | 36 | 5 | 13 |
| 60–80 | 95 | 19 | 20 |
| 80 plus | 31 | 7 | 23 |
| Totals | 181* | 32 | 18 |

NOTE: Of fifty-five patients under age sixty, six died (11 per cent mortality rate); of 126 patients over age sixty, twenty-six died (21 per cent mortality rate).

* Does not include taxis group or those not treated.

TABLE IV
DURATION OF INCARCERATION AND OPERATIVE MORTALITY IN HERNIA

| Duration | No. of Patients | Deaths | Mortality (%) |
|---|---|---|---|
| Less than 24 hr | 97 | 14 | 14 |
| More than 24 hr | 84 | 18 | 21 |
| Totals | 181* | 32 | 18 |

* Does not include taxis group or those not treated.

### ADJUNCT MEASURES

Ninety-three per cent of the patients were operated upon with either a Levin, Miller-Abbot or Cantor tube in place; also, most patients received antibiotics subsequent to 1946. Early in the series spinal anesthesia was most popular; later, general inhalation anesthesia was used frequently. In recent years a trend has developed toward regional and field block with 1 per cent procaine.

### FACTORS OF AGE AND DURATION OF INCARCERATION

Table III illustrates the comparative mortality rates in different age groups; one death occurred in a patient under forty. Table IV shows the increased lethality of prolonged incarceration. Causes of death and their incidence in the different types of obstruction are shown in Table V.

### COMMENTS

Parxagoras of Cos [5], a successor to Hippocrates, taught how incarcerations could be

TABLE V

CAUSES OF DEATH IN INCARCERATED HERNIA

| Cause of Death | Types of Obstruction | | |
|---|---|---|---|
| | Simple Incarcerations (65 cases) | Strangulated but Viable (82 cases) | Strangulated and Gangrenous (Over-all) (42 cases) |
| "Shock" | 1 | 1 | 3 |
| Cardiovascular accident | 4 | 7 | 3 |
| Infection: | | | |
| Pneumonia | 1 | 1 | 1 |
| Peritonitis | 0 | 0 | 10 |
| Pulmonary embolism | 1 | 3 | 0 |
| Aspiration of vomitus | 1 | 0 | 1 |
| Miscellaneous or undetermined | 0 | 2 | 0 |
| Deaths | 8 | 14 | 18* |
| Mortality (%) | 12 | 17 | 43 |

* Includes the eight cases not treated.

reduced by taxis. In later ages physicians and their competitors, the unlettered barber-surgeons, supplemented taxis with antispasmodics, cold compresses, warm packs, fomentations and opium. Later, venesection was added. In the eighteenth century the new drug tobacco was introduced, chiefly rectally. It was used in enemas, and also as smoke blown into the rectum with bellows, following which the patients often fainted, thus facilitating taxis. The operative repair of hernia began a slow rise to its present position in the sixteenth century. In 1589 Maupasius [5] performed the first operation for hernia, and Pierre Franco reduced incarcerations operatively, following with cautery to produce a scar. John C. Warren of Boston (1778 to 1856), pioneer in the use of ether anesthesia, was the first surgeon in this country to operate on a strangulated hernia. With the development of aseptic surgery and Marcy's, Halstead's and Bassini's work on hernia repair, surgeons came to consider incarcerations as pure surgical emergencies. Taxis was condemned because the sac might be ruptured, or gangrenous bowel reduced. In 1913 Alexander [1] said taxis should no longer be mentioned in medical school. Maingot [8] states that it is only justifiable if the patient flatly refuses operation. Wangensteen [12] says that taxis is a method of doubtful value.

In spite of these criticisms, Requarth and Theis [11] have pointed out that there are actually no reports in the literature statistically supporting the contention that taxis is dangerous. Lichtenstein and Frankhouser [7] reported fifty femoral incarcerations handled by manual reduction. Gross [6], in a large series of incarcerated indirect inguinal hernias in infants, manually reduced over 80 per cent. This was followed by elective herniorrhaphy in a few days, with the ease and safety of delayed operation consistently rewarding. Actually, it is uncommon to encounter an incarcerated hernia in an infant that cannot be reduced with sedation, care and gentle taxis.

Requarth and Theis [11] surveyed 500 cases of inguinal incarcerations at Cook County Hospital and found fully 60 per cent of them manipulatively reduced, with only one death due to the reduction (an unrecognized reduction *en masse*). The operated cases had a mortality rate of 16.8 per cent. The cases with advanced strangulation were too tender to be reduced; they state, "Gangrenous bowel is adherent to the sac by an inflammatory exudate which prevents reduction save by excessive violence." Our experience confirms this impression. We believe that the dangers of taxis reduction have been exaggerated. Using taxis intelligently, one cannot manually reduce a strangulated gangrenous hernia.

There was one fatality in our sixty cases of manual reduction and one in the series of

Requarth and Theis—both were cases of reduction *en masse*. Castens [2] collected 207 cases of this phenomenon from the literature. They occur in inguinal or femoral (primary or recurrent) hernias of long standing which have been manually reduced many times. The sac with its trapped contents is forced back through the femoral or inguinal aperture into a properitoneal position. The bulge disappears, but no true reduction has occurred. Pain and the symptoms of obstruction persist, and occasionally a tender mass can be palpated within the femoral canal, internal ring or on rectal examination. They can be detected if a reasonable "index of suspicion" and careful postreduction hourly observation is maintained.

## OBSERVATIONS

Incarcerated hernia is a common and serious surgical emergency, and surgeons over the last forty years have emphasized the dangers in manipulative reduction. Taxis, with its ancient origins, has fallen into official disrepute. However, the mortality rate in the surgery of incarcerated hernia is high even in the absence of strangulations (12 per cent at this hospital and correspondingly higher when vascular compromise has occurred) (Tables II and V.) Cole [3] and others have shown that aged patients tolerate elective operations unassociated with prolonged physiologic deformity as well as younger patients do. This is not true of emergency surgery. Moyer and Key [10] recently discussed this subject of operative risk, and state that it is the duration of physiologic upset that determines mortality in the aged. The vomiting and fluid loss of even a brief period of hernial incarceration may upset the delicate balances in an aged patient's cardiovascular, pulmonary, renal and cerebral systems, making him unable to cope with the added trauma of operation. Waugh [13] states that repair of a strangulated hernia carries at operation thirty times the risk entailed in repair of an uncomplicated hernia.

Our experience indicates that many inguinal incarcerations (30 per cent) can be safely reduced manually. At Cook County Hospital actually 60 per cent were so handled. Our figure for taxis reduction of femoral hernias was 13 per cent, for the umbilical variety 16 per cent, and for incisional defects 12 per cent. The only danger appears to be the infrequent reduction *en masse* which is easily detected. The expressed purpose of taxis is to convert an emergency situation (with high mortality) to an elective one (with negligible mortality). With successful reduction, preoperative evaluation and physiologic restoration can be carried forward. Particular attention should be directed to the lungs, urinary tract and colon. Chronic cough and straining on urination postoperatively invite recurrence. A hernia appearing, enlarging or incarcerating late in life may be a sign of increased intra-abdominal pressure from a partially obstructing "silent" colon lesion.

Failing successful reduction the simplest, briefest surgical measures to alleviate the obstruction are in order. Gastrointestinal suction decompression, electrolyte, fluid and whole blood replacement, and antibiotic "coverage" are all indicated. There is recent evidence [10] to indicate that the type of anesthesia used is not an important factor in mortality. However, Dennis [4] and others recommend local and field block with 1 per cent procaine. Our experience confirms that this is a safe and effective method.

If bowel of dubious viability is encountered, resection and anastomosis (either by closed or open method) is the treatment of choice. Small patches of gangrene, as might be encountered in a Richter's hernia, can be inverted by plication sutures.

The best treatment for incarcerated hernia is prevention by elective repair of all hernias as they are discovered. Incisional hernias are prevented at the time of original surgery.

## SUMMARY

1. A survey was made of 245 consecutive patients with acutely incarcerated external hernias treated with taxis and surgical procedures.

2. Manual reduction was accomplished in sixty patients; four underwent operation, with one death from reduction *en masse* recognized too late (mortality rate of 1.7 per cent).

3. Emergency operation was performed in 181 patients, with thirty-four deaths (mortality rate of 18.7 per cent).

4. With the increasing number of elective herniorrhaphies being performed, particularly in infancy, incarceration should become a diminishing problem.

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*We recommend:*

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# Fractures Involving the Distal Epiphysis of the Tibia and Fibula in Children

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MOST of us were taught in medical school that involvement of an epiphysis by a fracturing force before the epiphysis is closed would invariably produce some deformity. This was emphasized in textbooks, such as those by Magnuson and Stack and Key and Conwell, which show these deformities with regularity. The doctor on first treating such an injury in a child is constantly expecting deformity to appear and is constantly surprised to see a normal joint after treatment. Realization that all fractures in children which involve epiphyseal lines do not produce disturbances of growth or deformities or both occasioned a review of the cases of fractures of the distal epiphyses of the tibia and fibula in children encountered at the Mayo Clinic, as well as a review of the literature on these fractures. It seems that the deformity probably is not so much a certainty as we had been led to believe, certainly so far as the injury to these epiphyses is concerned. We hoped by our study to settle this question, "Does deformity follow all fractures of the distal tibial epiphysis and distal fibular epiphysis, or does it follow only a select few"?

Aitken in 1936 analyzed a series of twenty-one cases treated at the Boston City Hospital. From a study of these cases he was able to conclude that of all the forces and strains that could be applied to an epiphysis, only that force which resulted in crushing of the epiphysis would result in deformity. Although adequate reposition of an epiphysis was desirable, according to Aitken, lack of good reduction would not stop growth but would allow it to advance in another plane. Also, he stated that accurate and early reduction is most desirable but elaborate operative means should not be used to gain absolute reduction if nearly perfect apposition can be obtained by manipulation.

Giuliani, on the other hand, demonstrated to his satisfaction that every one of the traumatic displacements of the tibial and fibular epiphyses is followed by some degree of deformity. He claimed that the commonest deformity is a discrepancy in the length of the legs. He also mentioned that varus and valgus deformity of the ankle can occur as a late complication of this injury and stressed the advisability of osteotomy for correction. Hohmann, writing in the same year, concurred almost completely with Giuliani's attitudes, particularly with regard to the need for osteotomy in the correction of any deformity. Carothers and Crenshaw stated that growth deformity usually occurs in an adduction type of fracture.

In our study we analyzed the records of cases of injuries in children in the files of the clinic. The roentgenograms, taken prior to reduction and those taken following reduction by either operative or closed means, were reviewed as were the records of every other detail of treatment at the clinic. Whenever possible the patients were asked to return to Rochester for another set of roentgenograms and examination which involved estimation and measurement of the length of the extremity as well as the range of motion in the involved joints. By these means we were able to analyze twenty-seven fractures involving the distal tibial and fibular epiphyses which were treated at the Mayo Clinic during the years 1935 through 1952. None of the patients had received prior treatment and all were seen and managed by members of the staff of the Section of Orthopedics.

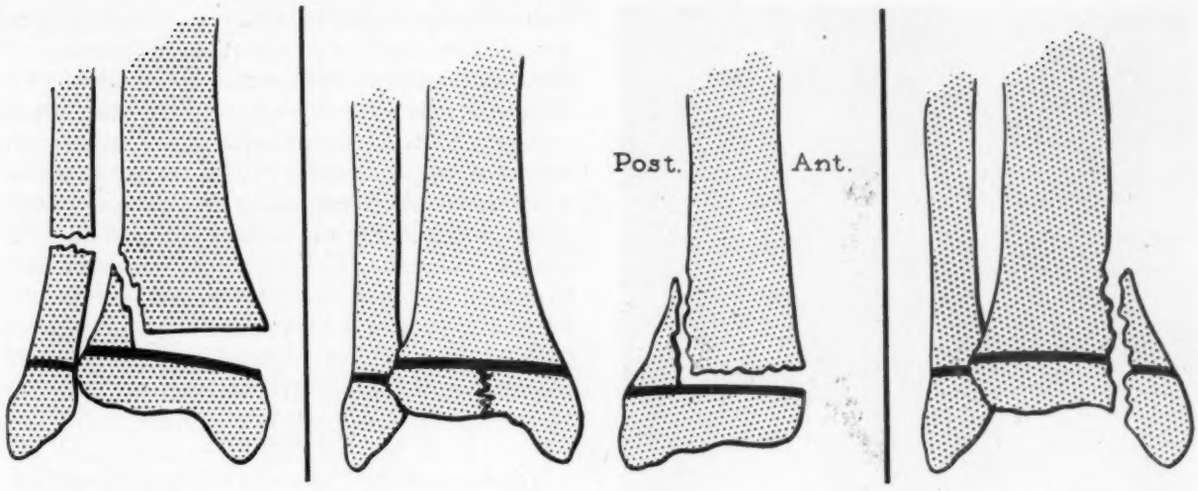


FIG. 1. Abduction type of epiphyseal displacement, anteroposterior view.

FIG. 2. Plantar flexion type of epiphyseal displacement; anteroposterior and lateral views.

FIG. 3. Adduction type of epiphyseal displacement; anteroposterior view.

This group of twenty-seven children was composed of sixteen boys and eleven girls. Their ages ranged between eight and sixteen years with the majority, sixteen in all, falling in the age group of twelve to fifteen years, inclusive.

### TYPES OF FRACTURE

As far as the mechanism of injury was concerned, it was often impossible from the patient's history to reconstruct exactly what the fracturing force was. Since in many instances the roentgenograms will give a clue to the method of fracturing or the type of force which created the fracture, we made a co-ordinated review of the roentgenograms and the histories. This gave us a good clue to the mechanism of injury in most instances.

The fractures which were seen were of four main types: (1) those which occurred in abduction, (2) those which occurred in plantar flexion, (3) those which occurred in adduction and (4) those that occurred in fibular epiphyses only. The fracturing force of the fractures which occur in abduction (Fig. 1) passes obliquely through the lateral distal part of the shaft of the tibia to the epiphysis and transversely proximal to the epiphyseal plate; thus it separates the epiphysis *en masse* and dislocates it laterally. There were eight such fractures in our group of cases, all with associated fractures of the distal portion of the shaft of the fibula. For fractures which occur in plantar flexion (Fig. 2), the stress is applied in a more vertical direction, so that the fracture appears in the bony epiphysis of the tibia and extends into the cartilaginous plate or if an anteroposterior line of force is added to the above fracture element, the epiphysis will be displaced posteriorly. There were ten such fractures in our group, one of which was accompanied by a fracture of the shaft of the fibula. When the fractures occur in adduction (Fig. 3), the talus is driven under the medial malleolus of the tibia and the fracture occurs through the epiphyseal cartilage from the joint and penetrates the shaft. There were five of these fractures in our group, none of which was associated with fractures of the fibula. Fractures of the fibular epiphysis only are produced by a mechanism similar to that of the fractures occurring in abduction. They have been considered separately, however, since an entirely different epiphysis is involved in many instances. However, fracture of the fibular epiphysis often accompanies that of the distal tibial epiphysis.

Aside from the bony and cartilaginous injury these fractures were remarkably uncomplicated. None were compound, but vascular insufficiency due to marked swelling and bony deformity occurred in one of the fractures of the abduction type. In this instance, however, circulation to the foot improved rapidly after manipulative reduction.

FIG. 4. (*a*) Abduction type of distal epiphyseal displacement of the tibia, preoperative anteroposterior view. (*b*) Position of fragments eleven months after open reduction and internal fixation, anteroposterior view.

### METHOD OF TREATMENT

Three main methods of treatment were used to handle the fractures occurring in this group: application of a cast, closed reduction and open reduction.

*Application of a Cast.* In nine cases there was no significant separation of the fragments and an application of a suitable plaster cast was all that was required. Of these nine cases one was an abduction type of fracture, six were the plantar flexion type of injury and two were fractures of the fibular epiphyses.

*Closed Reduction.* Satisfactory anatomic reduction was obtained by closed manipulation in sixteen of the twenty-seven cases. These were broken down according to types of fractures as follows: abduction type, six cases; plantar flexion type, four cases; adduction type, four cases; and fibular epiphyses, two cases.

*Open Reduction.* Operative repair was necessary in two cases when anatomic reduction was not possible by closed means. In the first of these, the fracture occurred in adduction; the medial tibial fragment could not be held in alignment with the ankle joint after closed reduction and subsequently a stainless steel screw was used through the fragment and across the epiphyseal line. The screw was removed five weeks later and the end result was excellent. In the second case, the fracture occurred in abduction. The anterior tibial tendon and a segment of periosteum were interposed between the displaced epiphysis and the shaft of the tibia. The reduction was held with two Collison screws and the end result was excellent. (Fig. 4.) One year later the patient had grown 3 inches without any evidence of shortening of the affected extremity.

### FOLLOW-UP

The immediate results of the treatment outlined were uniformly satisfactory. In no case was any deformity demonstrable immediately after removal of the fixation nor was epiphyseal arrest or irregular growth of any of the involved epiphyses apparent within a short follow-up period. Subsequently, these children were all contacted by letter, and we either saw and examined or obtained reports on fifteen of them. Twelve of these patients stated that they had no change in the injured ankle as compared to the normal one and that they had excellent range of motion and function in the ankle with no symptoms. One patient had required further operation which consisted of freeing of adhesions about the tendon of the extensor hallucis longus muscle, but he now was asymptomatic and had an excellent range of function and good strength in the ankle.

In three cases there were unsatisfactory results. The results in two were rated as unsatisfactory because of shortening and in the third because of cosmetic change. In the two instances in which shortening occurred there was a 1 inch and ½ inch difference, respectively, from the opposite leg. In no instance was the shortening a major disabling factor to the patient, and the second patient's attention was directed to the shortening only after it was discovered by actual measurements of the extremity. One of the injuries which resulted in shortening of the extremity was an abduction type of injury, and the other was a plantar flexion type.

Review of the roentgenograms with the knowledge that shortening existed failed to reveal any aspect which could lead one to predict the degree of shortening which did occur. Certainly there was no evidence in the

roentgenograms to show that compression of the epiphysis had resulted from the injury. In the third patient in whom the result was rated as unsatisfactory there was an enlargement of the medial malleolus following complete union of the displaced epiphysis. This was thought to be due to subperiosteal hematoma arising when the periosteum was stripped at the time of the injury. This injury was an adduction type of strain, and the cosmetic deformity was not of major consequence to the individual.

## COMMENT

Review of these twenty-seven fractures and follow-up data on fifteen patients have emphasized that certainly not all injuries to the distal epiphyses of the tibia and fibula result in some embarrassment of the function of this epiphysis. As far as our twenty-seven cases are concerned, we have not been able to substantiate the views held by Aitken that compression of the epiphysis in an axial plane is the one force which will result in changes in epiphyseal growth, since the two patients in our series in whom there were unsatisfactory results because of shortening of the extremity were not necessarily exposed to such axial compression of the epiphysis. However, from review of these cases we also were not able to agree with Carothers and Crenshaw that growth deformity usually occurs in the adduction type and that such growth deformity can be predicted from roentgenograms showing disruption of the epiphysis itself.

From our study of this small series of cases and our review of the literature, we have been able to conclude that accurate reduction of the epiphysis is to be sought most zealously. However, repeated manipulations or open operation is seldom necessary. It is to be expected that growth realignment will occur even late in the growing period, and one is probably justified in accepting some minimal degree of deformity early rather than subjecting the extremity to considerable closed or open manipulation. Also, in our opinion there is no evidence to suggest that massive displacement of the epiphysis by a fracturing force will result in clinically discernible change in growth.

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# Diagnosis of Posterior Lesions of the Medial Meniscus

## DESCRIPTION OF A NEW TEST

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*Presented before the Third Congress of the Society of Latin American Orthopedics and Traumatology, January 17, 1956, Mexico City, Mexico.*

ISOLATED lesions of the posterior third of the medial meniscus are frequently overlooked or misdiagnosed. The onset is often indefinite, complaints are vague and variable, and true locking is never present. Conservative therapy is of little benefit but an examiner is reluctant to advise surgery without a definite diagnosis. Such a state of indecision may allow the development of a recurrent synovitis with subsequent atrophy of the quadriceps muscle, joint instability and eventual early traumatic arthritis. Popliteal cysts, caused by pressure of the increased synovial fluid, also may complicate the clinical picture [*1*]. However, an early diagnosis of this cartilage injury should, and can, be made.

This paper is based upon observation and treatment of forty-two patients with such posterior meniscal disorders proved by surgery. The series seems small but this number was found only in the records of about 360 arthrotomies performed by the author for lacerations of the medial meniscuses, an incidence of about one in nine. However, since attention was directed toward this subject four years ago, the incidence of posterior to other medial meniscal lesions has been lowered to one in three. Watson-Jones [*2*] states emphatically that posterior lesions are no less common than bucket-handle tears but that such a diagnosis may be difficult and is often not made. I am in agreement except I am convinced that a reliable diagnosis can be made from the history and by several simple tests to be described.

In contrast to lacerations of the anterior or middle portions of the medial meniscus, the primary injury to the posterior horn rarely produces a synovial reaction and is not associated with damage to the medial collateral ligament. The patient, in fact, may not realize when the accident occurred. There is no true locking; pain is not severe and is often intermittent, but the patient is aware that the joint is not normal. Most of them have a "giving-away" sensation or a sense of instability at the joint when walking on uneven ground, going up and down stairs or making sudden turns with the knee flexed. Many complain that they are unable to squat or crouch down and that, if their work required such a position, they preferred to kneel on the affected joint.

Upon reviewing the histories of these forty-two patients one is impressed by the fact that the majority of them were doing, or had done, work which involved squatting or crouching down. This group included dairy farmers, roofers, painters, electricians, carpenters and plumbers. For example, a roofer may move from one spot to another while in a squatting position. He then may attempt to stand erect when in an awkward unbalanced situation with the knee in rotation. Since the posterior segment of the meniscus has been pulled toward the center of the joint when the knee was in full flexion, it may then be crushed between the articular surfaces of the femur and tibia when the joint is extended under such circumstances. The meniscus will return to its original position upon extension of the joint even though a laceration at the posterior horn or a loosening of the posterior peripheral attachment has occurred. After such initial trauma, the posterior segment is more vulnerable to re-injury if the patient continues to perform work requiring complete knee flexion. Many

FIG. 1. Duck-waddle test. The patient waddles back and forth and from side to side while in a squatting position.

of these patients volunteered the information that when crouching down there was a loud clicking at the knee associated with sharp pain at the posteromedial portion of the joint.

Based upon such observations, a duck-waddle test was devised which simulates the motions which originally produced the injury. If excess synovial fluid is present, the joint is aspirated prior to testing. The patient assumes a squatting position and then waddles back and forth and moves from side to side before arising. (Fig. 1.) This is a common conditioning exercise for football players even though in recent years it has been eliminated by some schools. A positive sign is indicated if the subject cannot attain complete knee flexion due to pain at the posterior joint or by clicking at the posteromedial portion of the joint usually followed by discomfort. The clicking is fairly constant and is produced in the last 10 to 20 degrees of flexion or during the early phase of extension from the fully flexed position. This test is rather strenuous and obviously cannot be performed by some patients, including the senile, obese and arthritic.

Five tests, including the duck-waddle maneuver, have been found most valuable in indicating this specific meniscal lesion. It may also be stressed that if these five tests are negative, the examiner may, with reasonable medical certainty, eliminate the probability of a posterior meniscal disorder being present. The tests are as follows: (1) duck-waddle test: positive in thirty-two of thirty-five patients (91.4 per cent); (2) pressure tenderness at the medial or posteromedial joint line with the knee in hyperextension and bearing weight with or without localized mild-to-moderate bulging: present in thirty-seven of forty-two patients (88.1 per cent); (3) pain on forceful adduction of the extended knee, none on abduction: present in thirty-one of forty-two patients (73.8 per cent); (4) McMurray's sign [3]: positive in twenty-eight of forty-two patients (66.6 per cent); and (5) Apley's sign [4]: positive in twenty-six of forty-two patients (61.9 per cent).

Repeated trauma to the posterior horn of the meniscus may produce multiple lacerations, complete detachment, degeneration, pedunculated fragments or even hypertrophy. With the joint in hyper-extension and bearing full weight, the cartilage (being changed in conformation) may be pushed medially. This produces a mild but definite bulging slightly posterior to the medial ligament with localized point pressure tenderness. (Fig. 2.)

Since the medial collateral ligament is not involved in isolated lesions at the posterior horn, there is no pain on abduction of the extended knee. Forced adduction, however,

may press some of the displaced meniscus between the articular surfaces of the joint and thus produce definite discomfort. (Fig. 3.) If pain is present on both forceful adduction and abduction, the response is considered negative.

The McMurray maneuver is done with the patient lying supine and the examiner standing at the side of the table. (Fig. 4.) The affected knee is brought into complete flexion and then with the tibia rotated laterally it is carried into extension and returned to its original position. This same maneuver is done with the tibia in forced medial rotation. A positive sign is indicated when there is a posterior clicking, usually associated with pain, which occurs at approximately the same angle each time, which is usually within 10 to 15 degrees of total flexion.

Apley's test is performed with the patient lying prone and the knee in 90 degrees' flexion. Downward pressure is made on the leg while the knee is being passed to complete flexion with the tibia in successive lateral and medial rotation. (Fig. 5.) A constant audible and tactile clicking is considered a positive response, as in the McMurray maneuver. In addition, these same knee motions are made with a pull upward on the leg which, by placing tension and torsion on the collateral ligaments, would determine if they were involved.

It must be emphasized, however, that there are no pathognomonic signs of this lesion. Diagnosis is a matter of judgment based on careful consideration of the history and interpretation of the various testing procedures. Most significant historical information is that of previous habitual weight-bearing deep knee flexion followed by recurrent increased fluid in the joint, a feeling of instability at the joint and vague discomfort at the posteromedial area of the articulation. Combining those complaints with positive responses to the five specific tests described previously, one may conclude with reasonable accuracy that a definite disorder exists at the posterior medial cartilage. Injections of gas or radiopaque solutions into the joint followed by roentgenograms give little evidence which could not be obtained by clinical examination.

The following three cases are typical of this condition.

FIG. 2. There is a localized bulging and point pressure tenderness at the medioposterior joint line with the knee extended and bearing weight.

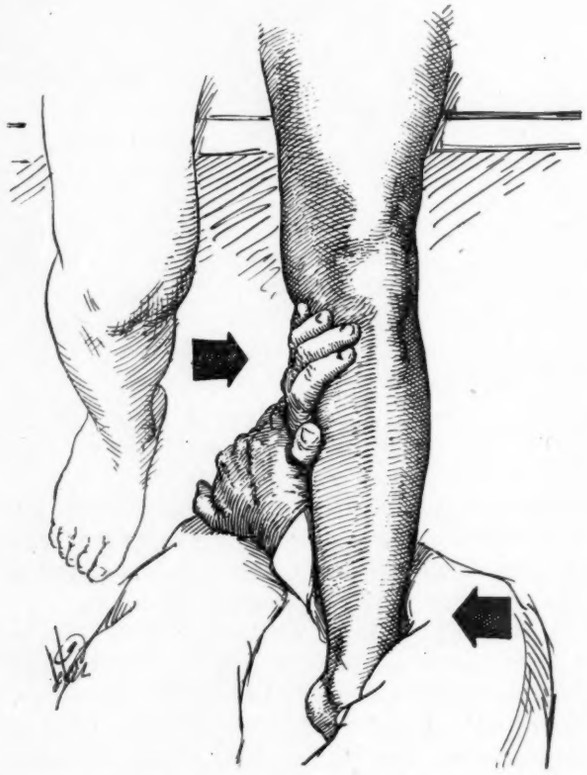

FIG. 3. Pain is experienced upon forced adduction of the extended knee; none on abduction.

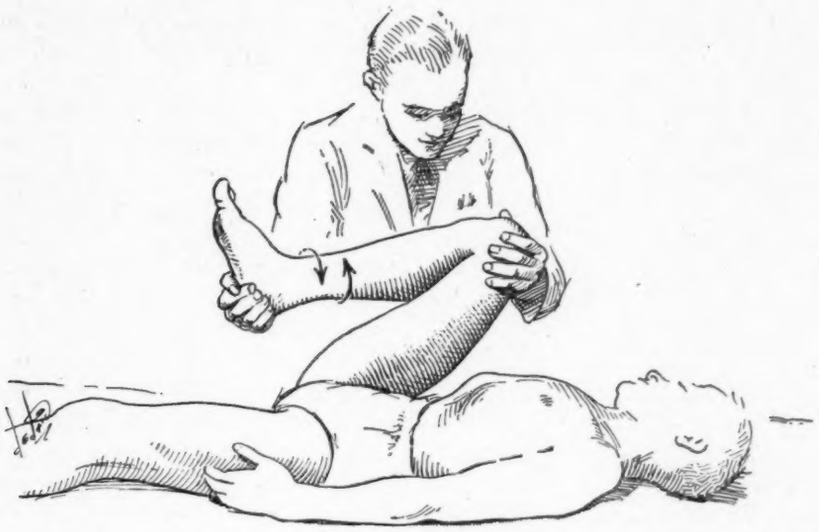

FIG. 4. McMurray's classic maneuver, a true indicator of posterior meniscal disorder.

FIG. 5. Apley's "grinding test" differentiates between meniscal and ligamentous disorder.

CASE REPORTS

CASE I. A forty-one year old dairy farmer complained of intermittent swelling and discomfort at the right knee of five months' duration. There was no history of injury. He was unable to squat down to apply suction milkers to a dairy herd as he had done habitually for many years. Examination of the knee revealed moderate atrophy of the quadriceps muscle, pain on adduction of the extended knee, pressure tenderness and bulging at the posteromedial portion of the joint line; McMurray's and duck-waddle signs were positive. At surgery multiple old lacerations at the posterior horn of the medial meniscus were found. Complete recovery followed meniscectomy. Ten months later this patient requested that surgery be performed on the opposite knee as he was convinced that he had a similar disorder of that medial meniscus. Examination confirmed his suspicion and at operation the posterior segment of the left medial cartilage was found to be hypertrophic and partly detached; in addition, two small lacerations were noted. Total meniscal excision resulted in an excellent recovery. When last seen one year later he was performing his usual dairy work and was able to squat down without difficulty or discomfort.

CASE II. A forty-three year old laborer, two years previously, had experienced pain at the right knee following a twisting injury when

he was stooping down to repair a machine. He continued to work but discomfort at the left knee persisted with increased fluid in the joint. Two months later a popliteal cyst developed. The cyst was aspirated several times by his attending physician and surgical excision was performed. Within six weeks the tumor recurred and excision was again performed, followed by another recurrence. The patient refused further surgery. When first examined by me two years after the original accident, he had marked swelling at the knee joint combined with a large bulging popliteal cyst at the medial aspect of the popliteal fossa. Aspiration of both the cyst and the knee joint was performed and tests were made for a meniscal disorder. A diagnosis of posterior medial disorder was made and arthrotomy was performed. The entire posterior horn of the medial meniscus was found to be frayed and hypertrophic. Total excision was performed. Early osteoarthritis and chronic synovitis were also present. Pain at the joint ceased but persistent synovial irritation remained. The popliteal cyst did not disappear and it was excised two months later. Recovery was gradual, but satisfactory, and he returned to work six weeks after excision of the cyst. When last examined two years later there was no recurrence of the cyst and the synovial reaction at the knee had completely subsided.

CASE III. A thirty-eight year old machinist injured his left knee six months previously by a twisting motion when the knee was in about 90 degrees' flexion. He also stated that he had previously been able to do work involving squatting or crouching down but at this time such motions were impossible due to pain at the left knee joint. There had been recurrent swelling of the joint and he had been treated by his family physician with bedrest and the application of a plaster knee cylinder. He continued to work but his condition was becoming progressively worse. A diagnosis of a posterior lesion of the medial cartilage was made but he would not consent to an operation. Finally, after another four months of partial disability, he requested surgery. Arthrotomy revealed a tear of the posterior third of the meniscus, with a portion of the cartilage lying between the articular surfaces of the femur and tibia. The synovium was thickened and injected. Recovery was excellent and he returned to work in five weeks, but increased fluid in the joint persisted for several months.

## COMMENTS

The first patient was the only one in this series who required surgery on both knees for similar disorders. The observation that a squatting position produced such a laceration at the posterior horn in each knee provided the basis for the duck-waddle test. Obviously the reproduction of the motions which produced the original injury would certainly elicit a response at the affected joint not to be had at a normal knee. The patient in Case II would have been saved from over two years of disability and probably three operations if an early correct diagnosis of the meniscal disorder had been made and he had been promptly treated by meniscectomy. The popliteal cyst may not have developed or, if present, may have disappeared of its own accord following correction of the primary cartilage tear. I have seen eight popliteal cysts associated with undiagnosed posterior medial meniscal lacerations. The resulting chronic synovitis causes a distention of the semimembranosus bursa which is connected to the knee joint. Case III illustrates the usual situation of a patient with partial disability who refuses surgery. Early arthrotomy would have eliminated ten months of disability during which time he did little or no work. Furthermore, his recovery, even after excision of the cartilage, was retarded due to the prolonged preoperative period of chronic synovitis and atrophy of the quadriceps muscle.

## SURGICAL TECHNIC

After the pneumatic tourniquet is inflated, a 7 to 8 cm. medial vertical incision is made with the knee in extension. Dissection is carried down to the capsule and the anterior flap is pulled forward about 3 cm. and a vertical capsular incision is made. The anterior portion of the joint is explored, particularly the articular surfaces of the patella, and the suprapatellar pouch is examined digitally using a clean glove. By dropping the distal table segment, the knee is brought into approximately 90 degrees of flexion. In some instances posterior lesions are visible if the knee is abducted and flexed about 110 degrees with the anterior portion of the meniscus being pulled forward with a clamp. In at least 50 per cent of patients, however,

with definite posterior medial laceration no lesion can be seen until the anterior and medial parts of the cartilage are detached. Even if chondromalacia of the patella or osteoarthritis of the joint is found, the medial meniscus should be excised despite the normal appearance of its visible portion. The basis of the chronic synovitis and changes in the joint could be due to an old concealed lesion of the posterior segment. If the entire meniscus cannot be removed through this anterior approach, the subcutaneous tissues may be retracted posteriorly and another vertical capsular incision made exposing the posterior portion of the joint. In obese or heavily muscled persons it may be quite difficult to perform meniscectomy even if two incisions are used.

After irrigation of the joint with physiologically normal saline solution with the knee in extension, all air and fluid are carefully expressed from the suprapatellar pouch. Puncturing the pouch in order to obtain subcutaneous postoperative drainage is of questionable value and in the cases observed has not lessened the postsurgical synovial reaction. An aqueous solution of penicillin, 500,000 units, is injected directly into the joint following closure. A pressure dressing and plaster knee cylinder are applied. Penicillin, 500,000 units, and ½ gm. of streptomycin are given twice daily for five days as a routine postoperative procedure. Early quadriceps exercises are instituted. The plaster casing is removed in one week and active and passive motions with partial weight bearing are begun.

## CONCLUSIONS

1. Posterior medial meniscal lesions are frequently overlooked and such neglect permits the development at the knee of chronic synovitis, instability, traumatic osteoarthritis and, occasionally, popliteal cysts.

2. Patients in occupations requiring a squatting or crouching-down position are more likely to sustain this particular cartilage laceration.

3. A reliable diagnosis can be made upon a careful evaluation of the history and the responses to five specific tests.

4. A new sign, termed the duck-waddle test, is described which simulates the knee motions that produced the original meniscal injury.

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# Superior Mesenteric Vascular Occlusion

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THE relief of catastrophic mesenteric occlusion, which requires resection of almost all the small intestine as well as the right colon, leaves much to be desired. Recovery from the operative procedure has been attained, only to have the patient succumb to a slow death. These cases are reported herein to stimulate some method of substituting at least part of the small bowel to delay the rapid egress of food, fluid and minerals from the gastrointestinal tract. We believe that resection must be performed, for the results are immediately fatal if anything less is done.

This report, we trust, may stimulate others to preclude our poor results.

Mesenteric vascular occlusion has been widely discussed in the medical literature for more than 100 years. Until recently it had been considered almost uniformly hopeless. However, several cases of survival after massive intestinal resection for mesenteric occlusion have now been reported. This has been made possible by the use of antibiotics, anticoagulants and the application of an increased knowledge of nutrition. Because it now appears possible to save some of these patients, the problem takes on practical importance.

We are limiting our discussion herein to primary mesenteric vascular occlusion with extensive intestinal ischemia. This precludes discussion of cases of limited intestinal infarction whether due to primary vascular occlusion, or secondary to trauma, sepsis or other etiologic factors.

Embolism or thrombosis of the mesenteric vessels is variously reported in surgical clinics as 0.02 to 0.015 per cent of all surgical admissions. In the last four years, of 12,000 surgical admissions to Queens General Hospital, there were ten cases of primary mesenteric thrombosis proved either by operation or at autopsy.

## PATHOGENESIS

There are three possible mechanisms to account for primary mesenteric occlusion: venous thrombosis, arterial thrombosis and arterial embolization. There can be no doubt that venous thrombosis is the most frequent mechanism in cases of infection, torsion, etc.

In patients with advanced obliterative arterial disease such as Raynaud's or Buerger's disease or periarteritis nodosa (also Whipple's disease), the arterial obliteration due to local thrombosis is probably the determining cause. Johnson has made a concentrated effort to differentiate between these three processes and he concluded that arterial embolization does not occur very frequently. Arterial embolization, however, in our opinion, is probably the most frequent mechanism in the absence of arterial disease. This was cogently substantiated by four of our ten cases, three of whom had fibrillation and two of whom had previous peripheral arterial embolization.

Mesenteric occlusion occurs more frequently in the superior mesenteric vessels than in the inferior. Maingot states that the ratio is 9:1. In the past five years at the Queens General Hospital no case of inferior mesenteric occlusion has been encountered. In contrast, ten proved cases of primary superior mesenteric occlusion have been encountered. We believe that occlusion of the inferior mesenteric vessels is extremely rare. This disparity may be explicable on the basis of two concepts: (1) arterial embolization is the more common cause of primary mesenteric occlusion and (2) the anatomic configuration of the origins of the superior and inferior mesenteric arteries facilitates the passage of the embolus into the superior mesenteric artery.

The superior mesenteric artery originates at the anterior aspect of the aorta, slightly

toward the right side and at an obtuse angle, almost parallel to the aorta. The inferior mesenteric artery is a smaller vessel and originates from the aorta slightly to the left of the midline at a more acute angle. The situation is analogous to the anatomic disposition of the tracheal bifurcation where the foreign bodies lodge predominantly in the right bronchus.

One objection to our explanation of this rare incidence of inferior mesenteric occlusion, however, might be that the inferior mesenteric artery has a better collateral circulation which will decrease the possibility of infarction in the corresponding intestinal segment.

Collateral circulation of the intestinal tract varies greatly. Terminal arteries of the bowel communicate through submucous plexuses, and experimental ligation of one terminal artery has no visible effect upon the bowel. Rothschild's experiments with dogs led him to believe that 10 to 15 cm. of bowel must be devascularized to produce an area of necrosis. Welch and Mall believe that the critical area is 5 to 10 cm. Sudden occlusion of a major vessel such as the superior or inferior mesenteric artery does not provide for sufficient collateral circulation. Gradual obliteration, however, of either mesenteric artery may be well tolerated until the arterial blood pressure distal to the occlusion is reduced to one-fifth of normal. The fall in the distal arterial pressure may be precipitated by systemic factors. Congestive heart failure may represent the determining factor in the infarction of an intestinal segment with a partially obliterated blood supply. We observed one such case.

### PATHOLOGY

This was first described by Virchow in 1847. Rives et al. [20] describe four stages in the course of mesenteric occlusion depending on the degree, extent and duration of the disease: (1) paralytic ileus; (2) ulceration of mucosa, with possible bleeding; (3) hemorrhagic infarction; and (4) perforation.

All infarcts of the bowel are hemorrhagic. This is due to a reflux stemming from the high venous pressure in the portal system. Occasionally, blood is found in the bowel and, infrequently, in the peritoneal cavity. Diagnostic paracenthesis has been recommended by Merscheimer et al [19].

### DIAGNOSIS

Superior mesenteric artery occlusion leads to gangrene of the intestine with all its implications. The one hope for these patients lies in prompt surgical intervention. Extension of thrombosis forming in continuity with a small embolus is a danger that must be considered. Early diagnosis and intervention may obviate the necessity for wider resection, at times incompatible with life.

One of the first symptoms is cramping abdominal pains caused by hyperperistalsis due to early ischemia. Distention follows and the picture of a paralytic ileus supervenes. Shock is very frequent and marked leukocytosis is almost constant. Nausea, vomiting and tenderness are variable findings. Hematemesis and melena may occur occasionally.

The diagnosis, however, remains a difficult one. Any history of cardiac disease is of great importance as the heart is the most frequent source of arterial embolus. Physical findings are usually not striking enough to indicate the catastrophic nature of the disease, and it must be admitted that both in our clinic and elsewhere the diagnosis has frequently been missed.

The diagnosis depends on (1) a history of cardiac disease, digitalis therapy or peripheral embolization; (2) pain in the abdomen, disproportionately severe in comparison with physical findings; (3) leukocytosis of 15,000 to 40,000; (4) gradually developing shock; (5) an x-ray suggestive of paralytic ileus; (6) distention in advanced cases; (7) hematemesis and melena.

### TREATMENT

We believe that resection remains the only feasible procedure in these cases. Isolated cases of recovery without resection have been reported. One of our own patients was thus managed after simple exploratory laparotomy showed early circulatory changes in the small bowel. Five days later the patient (S. K.) died of frank intestinal gangrene as proved at autopsy.

Patients who survive the immediate postresection period become difficult nutritional problems. Until recently it has been generally accepted that removal of the absorptive and digestive portion of the gastrointestinal tract, the mid-gut, was incompatible with life. This is contradicted by a number of cases in the recent literature.

Ample literature is available on the nutritional aspect of these postresection problems. In our series, we have corroborated most of the general findings of other authors. With regard to diet, we found no advantage to any of the predigested food preparations over a regular high protein, high caloric diet. Fats must be excluded because of their propensity of initiating diarrhea and calcium loss. The liberal use of blood transfusions is recommended. The fat-soluble vitamins must, of course, be given parenterally.

One of the great hazards in these patients is the development of an intractable diarrhea which is often the ultimate cause of death. The use of paregoric, kaopectate,® a low residue diet and frequent electrolyte determinations is emphasized.

### REVIEW OF CASES

Ten cases of mesenteric vascular occlusion were reviewed (Table 1) with the following findings:

The majority of patients were more than seventy-five years of age (youngest, fifty-two years; oldest, eighty-one years). There was no significant corollary between the patient's age and pathogenesis (embolus versus thrombosis) of the occlusion.

Of the ten cases presented, six were males and four were females, for a ratio of 3:2.

All of our patients were white, although the over-all percentage of Negro patients admitted to surgery is 26 per cent.

The time from onset of symptoms to admission ranged between six hours and three days. One-half of our patients were admitted within twenty-four hours of the onset of symptoms. In addition, four of the patients had intermittent abdominal pains prior to the acute onset with a time range of from forty-eight hours to three months. This might represent the so-called syndrome of "intestinal claudication."

In all but one patient (J. B.) there was a twelve-hour period between admission and operation. This delay never exceeded eighteen hours. When surgery was not performed, death supervened in four, five and nine days, respectively.

The clinical findings were as follows: Pain was generalized in four cases, confined to the right lower quadrant in four cases and to the left lower quadrant in one case. One patient had no abdominal pain and his main manifestation was gastrointestinal hemorrhage.

Hematemesis alone was present in two patients. Melena alone was present in two patients. Hematemesis and melena were present in one patient.

Shock supervened in four patients, three of whom did not undergo exploration. The fourth patient died on the operating table. This would indicate that shock occurs late in this process.

Palpable masses were present on abdominal examination in three patients: two in the right lower quadrant and one in the left lower quadrant.

Tenderness was elicited in seven patients. It was generalized at the onset and in four patients became localized to the right lower quadrant. Rigidity was found in only two patients, both of whom had bloody peritoneal fluid; one had peritonitis.

The white blood count ranged between 7,000 and 38,000. Three patients had counts over 30,000. The patient with the count of 7,000 died on the operating table. Although the correlation between the white blood count and the prognosis is difficult to appraise because three of our patients did not undergo operation, our observation is that the patients with the lowest white blood counts died within the shortest period of time.

A preoperative diagnosis was made in one, suspected in four and missed in five patients. The most common erroneous diagnosis was perforated viscus (appendicitis, colon diverticulitis or carcinoma). In four of five cases in which mesenteric thrombosis was suspected or diagnosed exploration was performed.

Eight patients had extensive gangrene extending from the region of the ligament of Treitz to the hepatic flexure. One other patient had gangrene of the proximal half of the ascending colon only. One patient had gangrene limited to most of the small bowel.

Seven patients underwent exploration. Resection was performed in five patients. One patient died during mobilization of the bowel. One patient underwent exploration without bowel resection.

Of the patients undergoing operation, one died on the operating table, one experienced evisceration on the eleventh postoperative day, and peritonitis developed in another from a leaking anastomosis; this patient died on the sixth postoperative day.

TABLE 1

| Patient | Onset to Surgery | Surgery to Death | Onset to Admission | Preoperative Diagnosis | White Blood Cell Count | Melena | Bloody Fluid (Abdominal) | Shock | Tenderness and Rigidity | Length of Resection | Complications | Cause of Death | Site of Pain | Hematemesis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. W. | 24 hr. | 33 days | 6 hr. | Made | 16,000 | Present | Present | None | Tenderness | Large bowel, 520 cm. | Evisceration | Malnutrition (diarrhea) | Generalized abdominal | None |
| L. M. | 24 hr. | 70 days | 10 hr. | Suspected | 37,000 | None | Present | None | Right lower quadrant | Ligament of Treitz and mid-transverse colon | None | Malnutrition | Generalized right lower quadrant | None |
| J. S. | 24 hr. | 21 days | Several hours | Suspected | 25,000 | None | Present | None | Generalized tenderness | Jejunum, 4 feet (gangrene) | None | Malnutrition (diarrhea) | Generalized abdominal | Present |
| D. N. | 4 days* | 0 | 3 days | Not made | 17,000 | Present | None | None at onset | Generalized tenderness | Not done | No surgery | Shock, uremia, pneumonia (?) | Low abdomen | None |
| O. V. | 2 days | 9 days | 2 days | Suspected | 38,000 | None | None | None | Tenderness, right lower quadrant | Anterior mid-jejunum | Mikulicz operation | Cerebro-vascular accident (?) | Right lower quadrant | None |
| S. K. | 7 days | 5 days | Previous 3 mo. | Not made | 10,000 | None | ..... | None | Tenderness, right lower quadrant | Not done | None | Massive infarction, intestinal exsanguination | Right lower quadrant | None |
| J. B. | 18 hr. | 6 days | 12 hr. | Not made | 12,000 | None | Present | None | Rigidity, right lower quadrant | Ligament of Treitz and mid-transverse colon, 390 cm. | Blown anastomosis | Peritonitis | Right lower quadrant | None |
| P. B. | 5 days* | 0 | 2 days | Suspected | 11,000 | None | Present | Present | Rigidity, left lower quadrant | Small and large bowel | No surgery | Shock and peritonitis | Left lower quadrant | None |
| G. T. | 9 days* | 0 | 12 hr. | Not made | 33,000 | Present | None | ..... | None | Small bowel (all) | No surgery | Shock | None | Present |
| L. D. | 36 hr. | Immediate | 24 hr. | Not made | 7,000 | None | Present | Present | Right lower quadrant | Small and large bowel | No surgery | Shock | Generalized abdominal | Present |

* Death.

Four patients underwent resection of bowel from within 2 feet of the ligament of Treitz to the region of the hepatic flexure. One died of peritonitis six days postoperatively. The other three patients lived twenty-one, thirty-three and seventy days, respectively. The oldest patient, with the most extensive resection, lived the longest.

Postoperative peritonitis accounted for one death. Shock caused by massive infarction was the immediate cause of death in three patients and was possible in two others. Inanition caused the death of three patients. One patient died of cerebrovascular accident.

## CASE REPORTS

The following two cases were selected for presentation because they serve to illustrate some of the contrasting features of this problem.

CASE I. L. M., an eighty-one year old white woman, was admitted on August 14, 1954, complaining of sudden onset of diffuse colicky abdominal pain of several hours' duration. She had been taking digitalis for the past year and had had auricular fibrillation for this period. Several months prior to admission, she experienced an episode of apparent arterial embolus in the right arm.

Physical examination revealed a well nourished, elderly white woman in acute distress. The blood pressure was 125/75, pulse was 150 per minute and irregular, respiration was 25 per minute. Occasional peristaltic sounds were heard. The abdomen was soft and non-tender to palpation with a tympanitic mass in the right lower quadrant. There was no radial pulse at the right wrist. X-rays of the abdomen were essentially negative.

Laboratory data were as follows: hemoglobin, 15 gm.; white blood count, 37,000, predominantly polymorphonuclears. Urinalysis revealed 1 plus sugar and a trace of albumin.

The patient was treated with intubation, but tenderness developed in the right lower quadrant within twelve hours after admission. The preoperative impression was appendicitis, or cholecystitis with perforation or mesenteric thrombosis.

On exploration a small amount of dark bloody fluid was present in the peritoneal cavity. Several loops of small bowel and right colon were gangrenous and the remainder of the small bowel was dusky grey. Viable bowel was found immediately distal to the ligament of Treitz and at the mid-transverse colon. No pulsations were palpable in the mesentery of the small bowel. Resection of the bowel from a point 5 inches distal to the ligament of Treitz and to the mid-transverse colon was effected with end-to-end anastomosis.

Postoperatively, the patient was given antibiotics, anticoagulants and intravenous fluids, including amigen® and alcohol and parenteral vitamins. Wangensteen suction was discontinued in twenty-four hours. Oral feedings were started on the fourth postoperative day and the patient was kept on a high protein diet. For the next six weeks the patient's bowel movements were maintained at from two to four semiformed stools per day with the aid of paregoric and kaopectate. In addition, the patient received four separate blood transfusions of 500 cc. each.

The patient lost 12 pounds during the first postoperative month and 6 pounds during the second. Two months postoperatively her condition deteriorated with the onset of marked diarrhea and psychosis. She died seventy days after operation.

The operative specimen consisted of 20 feet of gangrenous intestine. Autopsy was non-contributory.

CASE II. S. K., a sixty-five year old white man, was admitted on November 15, 1954, complaining of abdominal pain and vomiting of two days' duration.

For the previous three months, the patient had had intermittent cramping abdominal pains. Six weeks previous to the present admission, the patient was hospitalized at Queens General Hospital for similar complaints. Barium enema, gastrointestinal series and most of the other laboratory work-ups were within normal limits. The patient was discharged on November 12, 1954, with a diagnosis of Laennec's cirrhosis on the basis of an enlarged liver and a liver biopsy.

Physical examination revealed no abnormalities except for abdominal distention and tenderness over a palpable liver. The blood pressure was 160/80, pulse 98 per minute and temperature 100°F.

Laboratory data were as follows: hemoglobin, 10.2 gm.; white blood count, 10,900 with

78 per cent segmented neutrophils. Urinalysis was negative.

The first day after admission, tenderness and guarding developed in the right lower quadrant. No bowel sounds were audible. Abdominal tenderness, with occasional vomiting, persisted for the next four days. Exploratory laparotomy revealed congestion of the entire small bowel with engorged mesenteric veins. The portal pressure was 225 mm. saline. The liver was cirrhotic. The bowel was deemed viable and the abdomen was closed.

Postoperatively the patient's course went downhill and he died five days later.

Autopsy revealed Laennec's cirrhosis. There was generalized arteriosclerosis, especially marked in the aorta. The origin of the superior mesenteric artery was completely obliterated by atheromatous, ulcerative plaques with superimposed adherent thrombosis. There was massive hemorrhagic infarction of the small bowel.

## COMMENTS

Mesenteric vascular occlusion is not a pathologic entity but rather a complication of any number of other diseases. Therefore, the prognosis in mesenteric occlusion is necessarily dependent on the nature and severity of the underlying disease.

The occlusion may stem from: (1) far advanced aortic arteriosclerosis with thrombus formation, (2) emboli, usually of cardiac origin, (3) a variety of systemic diseases such as polycythemia vera, periarteritis nodosa, Raynaud's disease, Whipple's disease, Buerger's disease, and (4) ascending thrombophlebitis due to intra-abdominal infections (cases falling into causes (3) and (4) have not been considered in this paper).

Mesenteric thrombosis may be precipitated by a sudden fall in blood pressure, as in coronary occlusion, or acute cardiac decomposition.

The two cases presented illustrate how the course is dependent on the underlying pathologic process. In Case I the apparent mechanism was peripheral embolization of cardiac origin. Prompt surgical removal of a very extensive length of gangrenous bowel was followed by a quick and uneventful recovery and convalescence. By contrast, the patient in Case II, although much younger, had extensive ateriosclerosis with involvement of the descending aorta and atheromatous ulcers with thrombus formation at the origin of the superior mesenteric artery. We believe his premonitory symptoms of "intestinal claudication" of three months' duration can be explained on the basis of this mesenteric artery insufficiency. Autopsies of similar cases showed the same extensive obliterative arteriosclerotic changes.

On the other hand, mesenteric vascular occlusion secondary to embolization in patients who are otherwise in comparatively good health seems to have a more favorable prognosis. This is explainable on the grounds that the former is a progressive generalized disease in which mesenteric occlusion presents one of its terminal manifestations, whereas the latter is an accidental complication which, if promptly treated, offers some hope of recovery.

Patients who survive extensive resection are subject to early and late complications. In one of our patients evisceration occurred on the eleventh postoperative day, despite removal of 80 to 90 per cent of the intestinal tract. The most serious late complication is an intractable diarrhea, malnutrition and electrolyte imbalance. The relatively long survival of our eighty-one year old patient may have been, in part, attributable to the low metabolic rate of the aged.

## SUMMARY

The treatment of superior mesenteric vascular occlusion has been discussed. Ten cases of mesenteric vascular occlusion are reviewed.

All the occlusions were of the superior mesenteric artery or its tributaries. Seven patients were surgically explored and five underwent intestinal resection.

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Some followers of the German school believe that the exophthalmos in hyperthyroid cases is primarily due to an increase in the thyrotropic hormone of the pituitary gland. This hormone not only produces the bulging eyes but also helps to increase the growth, and hence the size, of the thyroid gland. They believe that partial or subtotal thyroidectomy or administration of antithyroid drugs, such as thiouracil, causes an increase in the amount of the thyrotrophic hormone of the pituitary, hence may aggravate the exophthalmos. They recommend therapy directly to the hypophysis (as x-ray therapy) or the use of other measures, in the milder cases, such as iodine therapy, itrumil,® ACTH, frenon (in the more severe cases), tapazole,® percorten® and even tonsillectomy, in the indicated cases. (*Richard A. Leonardo, M.D.*)

# Amputations in Peripheral Vascular Disease

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WE have been troubled by the great loss of time associated with the management of amputations for peripheral vascular disease. Recently the Massachusetts Medical Society [1] conducted a study of a group of 502 diabetic patients with foot complications. The cost of hospitalization in this collected series reached the considerable figure of $300,000. The committee emphasized, appropriately, the need for early recognition and good prophylaxis in these cases. Our analysis will be focused on the prolonged hospitalization of patients, both diabetic and non-diabetic, who have come to amputation. We are fully aware that in a sense amputation represents failure in treatment. We are convinced, however, despite recent advances in therapy and in vascular surgery, that amputations will be with us prominently for a long time. In our series, which covers a ten-year span, there has been no decline in the incidence of major amputations in the second as compared to the first five-year period.

It has been our purpose to collect and analyze all major amputations of the lower extremities performed in the Rhode Island Hospital over a ten-year period from 1945 to 1954. Since we have examined the daily operative schedules, we believe that the series is virtually complete. The number of cases is sufficiently large, in our opinion, to yield results which are statistically valid.

We have studied, in all, 344 records. These include major amputations (transmetatarsal, below-knee and thigh) for all causes. From this number we have excluded as not being pertinent to the subject thirty cases in which amputation was done for tumor, trauma or thromboangiitis obliterans. Of the remaining 314 patients, there were 169 with diabetes and 145 without diabetes. Among the diabetic patients there was a preponderance of females (60 per cent), whereas among the arteriosclerotic patients without diabetes there was a preponderance of males (65 per cent). The average age of all females was seventy years, and of males sixty-seven; the average age for the whole group was sixty-eight years.

The total number of thigh amputations during the ten-year period was 322. This includes bilateral procedures. There were, in all, thirty-six deaths. This amounted to a patient mortality of 12 per cent for the whole series, or an operative mortality of 11 per cent for the thigh operations (in which all of the deaths occurred). This is a significantly high mortality rate, giving full consideration to the physical status and the age (average age at death, seventy-four years) of these patients. Ten postmortem examinations were performed, a rate of 26 per cent. In general the verified causes of death were consistent with advanced age and degenerative disease. Two deaths were due to pulmonary embolism. One of these was established by autopsy but in the other case postmortem examination was not performed, the diagnosis having been made on clinical grounds. This is a lower incidence (0.6 per cent) than had been anticipated. Femoral vein ligation had not been performed on either of these patients.

Early in the analysis of this material we were impressed by the high average length of hospitalization. We shall now turn our attention to the causative factors. In determining the length of hospitalization we have arbitrarily utilized a period beginning six months before definitive surgery and ending on the date of the patient's discharge from the hospital. The average hospital stay for patients having thigh amputations was forty-three days. There appeared to be a slight reduction in the length of hospitalization in the second

five years (average forty-one days) as compared to the first five years (average forty-six days). A separate determination of this factor for private cases revealed no significant variation from the whole group (average forty and forty-five days, respectively). The average postoperative convalescence for the whole group was twenty days. We have been unable to establish any specific criteria with respect to the technical operative procedure that might lower significantly the postoperative stay. We believe, nevertheless, that the postoperative period is somewhat prolonged. It is reasonable to assume that it might be shortened by more attention to delicate operative manipulation and early rehabilitation.

Analysis of the factors involved in the prolonged preoperative stay is more revealing. For that purpose a group of patients was selected whose thigh operation was preceded by one or more of the following procedures: sympathectomy, toe amputations, transmetatarsal and below-knee amputations. Many patients in this group underwent several operations. There were eighty-seven of these patients, or 27 per cent of all those having thigh amputations. The total hospitalization in this group was fifty-five days. Since the postoperative convalescence of these patients averaged twenty days (not significantly different from the whole group), it is evident that the increase is attributable to prolonged preoperative stay. Since all of these patients were ultimately subjected to thigh amputation, it may seriously be questioned whether they were wisely selected for a conservative approach. Contrariwise those 235 patients having no surgery preceding thigh amputation had an average hospital stay of thirty-nine days, a difference of sixteen days. Our data could not be used to support an argument for radical approach in all cases. It appears, however, that there is room for improvement in the selection of cases for conservative treatment and in earlier recognition of failure. A perusal of individual protocols seems to support this view.

The group of eighty-seven patients undergoing multiple operations is interesting in several other respects. There were 73 per cent diabetic patients as compared to 52 per cent for all patients. The average age was sixty-five as compared to 68.5 for the whole group. Twenty-eight per cent left the hospital with unhealed stumps, as compared to 22 per cent for all patients, which in itself seems an unreasonably high incidence. We are unable to explain the increased incidence of impaired healing in the smaller group, but the influence of repeated surgery and prolonged hospitalization cannot readily be dismissed. It would seem further that the presence of diabetes and the factor of lower age must not weigh too heavily in favor of selection for limited procedures.

To elucidate the problem further, below-knee and transmetatarsal operations were considered separately. There were thirty-eight below-knee amputations, of which twenty-seven or 71 per cent were successful. This represents a fair degree of success. Of ten closed transmetatarsal operations, however, only two or 20 per cent yielded a good result. There were, in addition, two open transmetatarsal operations with subsequent skin grafting which were successful, increasing somewhat the good results at this site of amputation. Failures of 29 and 80 per cent would not be readily accepted, however, in other fields of surgery.

One additional point is worthy of note: Sixty-five or 19 per cent of all patients undergoing thigh amputation had undergone previous sympathectomy.

Our experience with bilateral amputation may be of some general interest. Forty-four or 14 per cent of the patients in the series were subjected to bilateral major amputation (thigh and below-knee). In thirty-eight instances both procedures were performed during the period of investigation. Six occurred during a single hospital admission. The average interval between amputations was 1.5 years.

## COMMENT

In undertaking this study we had hoped to discover some technical criteria upon which better results might be based. Factors analyzed included length of flaps, level of amputation, especially in the thigh group, and use of femoral vein ligation, unilateral or bilateral. Neither the average period of convalescence (twenty-one days) nor the incidence of unhealed stumps at time of the patient's discharge from the hospital (22 per cent) was influenced by these factors. Fifty-nine patients had either unilateral (thirty-one) or bilateral (twenty-eight) femoral vein ligation. This constituted 16 per cent of all thigh and below-knee amputations. None of these patients succumbed to thromboembolic disease, but the

group is too small to be of statistical significance with respect to a complication of low incidence.

Our mortality rate (11 per cent) compares favorably with the best recorded in the literature. It appears, further, that our average hospitalization is not out of line with experience in other clinics. If this be true, the results reported herein would seem to warrant a new look at the whole subject. The adverse effect of prolonged hospitalization and procrastination on healing and rehabilitation must be recognized. Despite the high incidence of concomitant degenerative disease and the difficulty of the over-all problem, means must be sought to lessen mortality and morbidity and to reduce the period of hospitalization. This study has disclosed no reasons to consider these goals unrealistic or unattainable. Even though it has not been possible to base recommendations on measurable surgical criteria, adherence to sound surgical principles should, nevertheless, accomplish much.

In pursuit of this objective, maximum respect for tissue and gentle handling cannot be overemphasized. Early and sustained attention to rehabilitation will also aid in the reduction of morbidity. More essential, however, is the application of sound surgical judgment. This involves a fair evaluation of the patient with respect to his ultimate potentialities and an accurate estimate of his collateral circulation. There should be a minimum of delay in the recognition or acceptance of the inevitability of amputation. Prompt admission of failure in limited operations is equally important. An astute estimate of collateral circulation remains, however, the fundamental basis on which improvement can be achieved.

## CONCLUSIONS

1. The average length of hospitalization in patients having amputation for peripheral vascular disease is unduly long.

2. Improvement in results must depend on closer adherence to sound surgical principles. Collateral circulation is the single most important factor to be evaluated.

3. Conservative treatment or limited surgery should be undertaken only after a realistic appraisal of the probability of a successful outcome. Early recognition of failure is essential.

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Roentgen Interpretation of Fractures and Dislocations. By Joseph Levitin, M.D., Chief, Department of Radiology, Mount Zion Hospital; and Ben Colloff, M.D., Associate Chief, Department of Orthopedic Surgery, Mount Zion Hospital, San Francisco, California. 265 pages, 258 figures (many diagrammatic), with bibliography and index. Springfield, Ill., 1956. Charles C Thomas.

# Venous Thrombectomy in the Management of Acute Venous Thrombosis of the Saphenous System

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THERE is the general opinion that acute venous thrombosis or acute thrombophlebitis occurring in the saphenous system of the lower extremities is best managed by conservative measures, and that the complications and residual effects are minimal. The usual episode of superficial phlebitis occurring below the knee in the patient with pre-existing varicosities is followed with few residual manifestations. On the other hand, we have gained the impression that an episode of thrombosis occurring in varicosities at the region of the knee, or above, is of a different character from the standpoint of frequency of propagation proximally and the frequency of propagation into the deep venous system.

We have reviewed our experience with the surgical management of venous thrombosis of the saphenous system at Mercy Hospital over a four-year period from 1952 to 1955, inclusive. Of this group of patients, ten were treated surgically. Six of these patients had a thrombus of the saphenofemoral junction, associated with acute venous thrombosis, occurring in preexisting varicosities. In four patients exploration failed to reveal a thrombus at the saphenofemoral junction. Results of the operative management of these patients have prompted this report.

The following is the surgical method which we employ at present in performing thrombectomy and ligation for acute venous thrombosis of the saphenous system.

## TECHNIC OF OPERATION

The patient is placed on the operating table with his body and head elevated at an angle of approximately 15 degrees in order to increase the venous pressure at the saphenofemoral junction. The leg is not scrubbed because of the danger of breaking off an embolus. The site of incision over the fossa ovalis is infiltrated with 1 per cent novocain.® An oblique incision is made over the fossa ovalis. The tissues are carefully dissected down to the saphenofemoral junction. The saphenous vein is carefully dissected for an area of 2 or 3 inches. Many times the saphenous vein will be found to be thrombosed. When this is the case, two umbilical tape cords are placed under the vein at different levels. The thrombosed vein is incised and thrombectomy performed, the clot removed proximally either by a Percy or Randall forceps, or with suction attached to an eye dropper or small catheter.

We have feared the possibility of breaking off a portion of the clot with this extension into the deeper circulation. So far in our experience this has not occurred, possibly because the patient is placed on the operating table in a slightly reversed Trendelenburg position, and is urged to strain and cough so as to extrude any clots which might be present and until brisk bleeding occurs from the proximal saphenous vein at the fossa ovalis.

If a clot is encountered which extends beyond the saphenofemoral junction, it is sucked out of the common femoral vein. A free flow of venous blood from the proximal saphenous vein is essential. After the occurrence of brisk

bleeding the saphenous vein is clamped, cut and doubly ligated flush with the common femoral vein with a distal transfixed ligature. This is the usual procedure employed by us in combination with the stripping technic, as described in a previous article [1]. If no clot is present at the saphenofemoral junction, the vein is clamped, cut and ligated.

The clot in the distal vein is gently extracted by a Percy forceps with a small ring tip, or aspirated out as previously described for the proximal end. In addition to this, in recent years we have been injecting novocain into the skin over the thrombosed area, either above or below the knee, or both, incising the skin and dissecting and removing the thrombosed vein.

Pressure sponges are applied over the closed incision and the leg is wrapped with an Ace bandage from the foot to the groin. The patients are ambulatory after the operation.

In all six cases presented herein there were findings of a thrombus at exploratory surgery, with various degrees of extension into the common femoral vein at the saphenofemoral junction.

### CASE REPORTS

CASE I. H. P., a sixty-five year old woman, was undergoing psychiatric treatment for a depression reaction. Spontaneous thrombophlebitis developed in pre-existing varicosities over the medial left thigh region. Evidence of extension into the great saphenous vein was present proximally. The saphenofemoral junction was explored. On opening the great saphenous vein, a clot was noted extending into the common femoral vein. Thrombectomy was performed and immediate brisk bleeding was noted both proximally and distally. The saphenous vein was then ligated flush with the common femoral vein and additionally suture-ligated. Phlebectomy was performed through a short vertical incision; the area of thrombophlebitis was exposed and multiple tortuous thrombosed veins were removed and ligated. The patient's recovery was rapid and complete.

CASE II. W. C., a forty-four year old man, related a history of one week's soreness, redness and localized swelling over the left medial area of the knee at the site of enlarged varicose veins. No precipitating factor was elicited. Examination revealed minimal varicosities of both lower extremities. Two areas just superior and inferior to the left medial region of the knee revealed tenderness, induration and redness. A tender cord could be palpated extending toward the groin. The impression was spontaneous thrombophlebitis of varicosities of the left lower extremity. The left saphenofemoral junction was explored. The great saphenous vein was found to be filled with a non-adherent clot projecting into the common femoral vein. Thrombectomy was performed and immediate brisk bleeding occurred from the proximal and distal ends. The saphenous vein was then ligated flush with the common femoral vein and additionally suture-ligated. Through a separate short incision, phlebectomy was then performed in the area of the thrombosed knee with ligation proximally and distally. Recovery was rapid and complete, and the patient was remarkably free of discomfort.

CASE III. F. S., a sixty year old woman, suffered a progression of pain in the medial aspect of her right thigh for six weeks, associated with sharp pains radiating to the knee. Examination revealed a warm, swollen right thigh with a distinct, large, swollen, tender, red area over the medial aspect. The diagnosis was superficial thrombophlebitis. The right saphenofemoral junction was explored. On opening the saphenous vein a 3 cm. clot was encountered. Thrombectomy was performed and immediate brisk bleeding occurred from the proximal and distal ends. The saphenous vein was then ligated flush with the femoral vein and further secured with a suture ligature. Phlebectomy was performed through a short vertical incision. The patient's recovery was rapid, with minimal discomfort in the leg.

CASE IV. J. T., a forty-two year old man, had had varicosities in both lower extremities for years. Ten days prior to admission he had suffered a blow to the right lateral knee region, which subsequently became tender, red and warm, spreading upward to the groin. Several days prior to admission a tender, indurated, red area was noted in the right groin. Examination revealed a tender, warm area over the site of dilated veins at the lateral knee region and following the course of the right saphenous vein to the groin. A localized tender, appar-

ently fluctuant area was noted just below the inguinal ligament in the groin. The right saphenofemoral junction was explored and a clot measuring 5 cm. was found. Thrombectomy was performed and immediate brisk bleeding occurred from the proximal and distal ends. The saphenous vein was ligated flush with the femoral vein and additionally suture-ligated. Through a separate short incision phlebectomy was then performed and the thrombosed veins in the lateral knee area were dissected and removed. The patient made a rapid and complete recovery.

CASE V. H. C., a fifty-three year old woman, related a three- to four-month history of tenderness and swelling of the right thigh, initially intermittent and then progressive for two to three weeks, with increased tenderness, warmth and edema of the right leg. Examination revealed marked varicosities of the lower extremities, with a rather severe thrombotic process involving the saphenous system of the right thigh. A tender cord could be palpated, extending toward the groin and iliac regions. The right saphenofemoral area was explored and a firm clot measuring 5 cm. was found extending into the common femoral vein from the saphenous vein. Thrombectomy was performed and immediate brisk bleeding occurred. The saphenous vein was then ligated flush with the femoral vein and additionally suture-ligated. Phlebectomy was then performed through a short vertical incision. The patient suffered only mild discomfort postoperatively and made a rapid recovery.

CASE VI. E. G., a fifty-six year old woman, developed pain at the site of varicosities in the left leg fourteen days prior to admission. Subsequent tenderness and redness with swelling was noted in the left groin. Examination revealed pain, tenderness and redness along the saphenofemoral area to the iliac vessels, with tenderness and swelling of the left thigh. The left saphenofemoral junction was explored and a thrombosed and thickened saphenous vein was revealed, with surrounding marked inflammatory reaction. A clot extending into the femoral vein was immediately apparent. Thrombectomy was performed, resulting in brisk bleeding from the femoral vein. The saphenous vein was then ligated flush with the femoral vein and additionally suture-ligated. Phlebectomy was next performed and multiple thrombosed veins were removed distally to this point, with ligation and division of the saphenous vein. The patient's recovery was complete.

## COMMENTS

Experience with the operative management of acute venous thrombosis occurring in the saphenous system has led us to consider the method of thrombectomy and ligation as the treatment of choice. For the most part, to our knowledge episodes of thrombosis occurring in pre-existing varicosities of the lower extremities are regarded by most as a very mild complication and are treated by simple or nonoperative means during the acute phase. That this is a rational method in most cases has been shown by experience when the site of the thrombosis is below the knee. However, it becomes a different situation when the site of thrombosis lies above or just at the knee, and manifestly when there is evidence of extension proximally in the course of the great saphenous vein to the groin. There is no reason to believe that there is not a significant incidence of propagation into the saphenofemoral junction —an incidence of 60 per cent in our series.

Hermann [2] states that ". . . real danger lies in the spread of the process of thrombosis to the deep veins." In his opinion, complete excision of the involved vein and its clots, performed in the early stages, is a simple and safe procedure.

Osius [3] states that he has previously recommended immediate ligation with thrombectomy, to be performed as an emergency procedure.

It is problematic that a pulmonary embolus could occur, but the evidence is there, as demonstrated in our case reports. Vaughn and Lees [4] have shown that pulmonary embolism can occur from superficial vein thrombosis. When deep venous extension occurs, it presents the same situation and dangers as any deep venous thrombosis. Osius suggests the possibility of embolism when deep venous propagation exists.

In 1954 Mahorner [5] proposed a new type of management for deep venous thrombosis aimed at the concept, with which we agree, to "Get the lumen of the vein open and keep it open."

Briefly considered, it consisted of thrombectomy without ligation, and administration of an anticoagulant (heparin) immediately after surgery, a method he used in six cases with brilliant results. He recommended this operative management particularly for extensive venous thrombosis with massive edema. He emphasized a belief shared by more and more surgeons, that no deep vein is ever ligated with impunity; residual edema is always present to a degree. We might add that no deep vein, particularly the common femoral vein, ever is occluded by a clot without residual manifestations.

Since no disability results obviously from ligation of the great saphenous vein and its tributaries when the deep circulation is competent, we have performed this ligation after the thrombectomy. Anticoagulant therapy has not been used and has not been thought to be helpful. We are impressed, as a lesser consideration, with the minimal postoperative discomfort experienced by the patient, the reduced morbidity, the speed of recovery and the short period of hospital stay necessary.

Superficial venous thrombosis may occur during pregnancy. We have not hesitated to ligate the saphenous vein at the groin during any stage of pregnancy when a painful thrombosis has occurred, providing the deep venous circulation is adequate.

We have been impressed with the rapidity with which these thrombosed veins regress after the high saphenous vein ligation, and also after the excision of the thrombosed vein.

## SUMMARY AND CONCLUSIONS

A different clinical entity exists when the site of thrombosis of varicosities of the greater saphenous vein is above or just at the knee.

Extension of a propagating clot into the common femoral vein from the saphenous vein occurs in a significant incidence; 60 per cent in our series.

The operative management of this condition probably prevents or minimizes the possibility of pulmonary embolism and/or the postphlebitic syndrome, and shortens the convalescence and discomfort.

The technic of thrombectomy and ligation employed by us has been presented.

Experience and satisfactory results with surgical treatment in the form of thrombectomy and ligation, in our hands, lead us to advocate surgical exploration in patients with acute venous thrombosis of the saphenous system.

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# Diagnostic Value of Paracentesis in the Acute Surgical Condition of the Abdomen

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THE diagnosis of the acute surgical condition of the abdomen is in many instances challenging and complex. Of the diagnostic aids presently employed, abdominal paracentesis is the least utilized. This simple procedure has received practically no recognition in recent surgical textbooks and was not mentioned in the "Early Care of Acute Soft Tissue Injuries" by the Committee on Trauma of the American College of Surgeons. In many instances, by employing minimal equipment which is readily available a definite diagnosis can be reached in certain diagnostic problems. The indications, contraindications, complications and relative safety of abdominal paracentesis should be better understood. The various diagnoses which can be aided by this technic will be outlined. Appropriate clinical observation and laboratory procedure will be discussed. This procedure has been used in the past nine years at the Louisville Veterans Administration Hospital without a single accident. Since the procedure was not coded, most of the early paracenteses have been lost; but we have reviewed twenty-three of the more recent cases at the hospital and have collected eight in our private practice. In all but two of these the procedure has led to the correct diagnosis, and in those two cases it was not entirely conclusive and was therefore disregarded.

## TECHNIC

Various sites for the introduction of the needle have been used, and the position of the patient during the tap also has varied. We employ tapping in the dependent lower quadrant of the abdomen with the patient in the lateral decubitus position. If a negative tap is encountered on one side, the opposite side is likewise tapped. A 10 cc. syringe is used along with the Potter pneumothorax needle. This needle is employed because its laterally placed aperture and obtusely bevelled end insures greater efficiency and safety. However, if the Potter needle is not available, second choice is a No. 18 or 20 gage spinal needle or ordinary short bevelled venipuncture needle of similar size and adequate length. Aspiration in the region of a mass, a scar or in the region of the bladder should be avoided. Denzer [5] believes it is important that the syringe be depressed flat on the abdomen so that the point of the needle is close to the peritoneal surface, for he believes that there is a tendency for the fluid, if only in small quantities, to form a film along the parietal peritoneum. Air leak into the peritoneal cavity at the time of the tap should be avoided because there is greater ease of aspiration if this film is not broken. A great quantity of fluid is not necessary for diagnosis. Even a drop or two is adequate for smear and culture [6]. In fact, as stressed by Denzer, no fluid may be apparent; but if suction is maintained while the needle is removed, a tiny drop may appear which can be utilized and the resulting smear may reveal pus cells and the offending organisms. Denzer has found this particularly useful in differentiating primary and secondary peritonitis. Chemical determinations can be completed with appropriate correction for dilutions when using very small quantities. In cases in which carcinomatosis is suspected, sufficient quantity for cell block will be helpful.

In most instances local anesthesia is used, although it is not necessary. Little difficulty will be experienced in recognizing when the needle enters the peritoneal cavity, as the characteristic "give" is felt as the needle traverses the peritoneum.

### INDICATIONS AND CONTRAINDICATIONS

Abdominal paracentesis is indicated in any case in which the diagnosis or course of treatment remains uncertain and one of the following conditions is considered: *Inflammatory:* primary peritonitis, secondary peritonitis, bile peritonitis, pancreatitis, perforated viscus, strangulated bowel, chylous ascites. *Neoplastic:* carcinomatosis, pseudomyxoma peritonei. *Traumatic:* intraperitoneal hemorrhage, multiple severe injuries with possible intra-abdominal injury, injuries to head with persistent shock without sufficient apparent physical reasons, ruptured urinary bladder.

We have found no true contraindication if the simple safeguards mentioned under "Technic" are followed, i.e., avoiding masses, scars and the bladder. Neuhof and Cohen [6] suggest the inadvisability of tapping in a patient with a chronic or subacute intraperitoneal lesion that may fix a loop of intestine. We believe that if bowel is adherent to the peritoneum at the puncture site, puncture might occur; but this would be of little consequence since there would be no leakage into the peritoneal cavity. Aspiration in suggested acute intestinal obstruction with considerable distention has been performed without the occurrence of puncture of the intestine [4]. However, if there is marked distention, we have elected not to employ the procedure. We perforated the cecum in one such case but without demonstrable ill effect.

### SAFETY OF PROCEDURE

The procedure is a safe one, as evidenced by the complete absence of complications in all the series reviewed totalling over 400 cases. In nine years' experience at the Louisville Veterans Administration Hospital there have been no complications which could be attributed to this procedure. Neuhof and Cohen [6] reported no injury to the bowel or any accident in "more than one hundred cases." Thompson and Brown [2] have described 300 cases of diagnostic paracentesis with no resultant complications. Denzer [5] has reported fifteen years of using the procedure without untoward incident. If the needle were to enter the bowel accidentally, which is unlikely since the bowel slips away from the point of the needle and considerable force is needed to enter its lumen, it could be anticipated that the wound would promptly seal and little harm would result.

### EXAMINATION OF ASPIRATED FLUID AND ITS CLINICAL APPLICATIONS

Much can be learned by gross examination of the fluid, its odor, color, texture, whether clear or cloudy and whether bloody, purulent, etc. Laboratory analyses are usually indicated, such as specific gravity, smear, culture and cytology, and tests for acid reaction, amylase activity and bile.

In acute pancreatitis the fluid is watery, odorless and appears blood-tinged to reddish brown. Keith, Zollinger and McCleary [1] noted turbid yellow fluid in interstitial pancreatitis and reddish brown fluid in the hemorrhagic type. Gross and microscopic fat globules are often present in both conditions. The amylase level is elevated and usually remains so several days after the serum determination returns to normal [1]. Thus it is of particular aid when the patient presents residual signs and symptoms relatively late in the course of hemorrhagic pancreatitis with normal serum amylase. It must be remembered that abnormal levels of abdominal fluid amylase are also occasionally noted in ruptured ulcer and in strangulated bowel.

In perforated ulcer the fluid tends to be odorless, turbid or purulent with flecks of amorphous, fibrinous material, and as a rule gives a positive test for bile and also for acid [1].

In the presence of gangrenous or perforated bowel, hemorrhagic to purulent fluid, often of foul odor, will be aspirated. Microscopy of fresh or stained material will reveal leukocytes with a variety of organisms.

In primary peritonitis, pus cells with gonococci, pneumococci or streptococci in unmixed state will be recovered and operation will be contraindicated. On the contrary, a purulent fluid with or without gram-negative rods and other mixed bacteria point to secondary peritonitis and to the necessity of surgical exploration.

Rarely the needle will perforate a loop of bowel; in this case amorphous material often mixed with air bubbles and containing multi-

ple types of bacteria but no pus cells will be recovered.

Fluid blood when there is no history of injury suggests a ruptured graafian follicle, tubal pregnancy or the rare condition of abdominal apoplexy.

In suspected carcinomatosis an inflammatory type of fluid would be expected. This should be spun down in the centrifuge and the residue imbedded for cytologic examination.

Following trauma abdominal signs and symptoms may be minimal, making the decision for or against laparotomy quite difficult. The latent period before shock in early rupture of the spleen and liver is well known. Paracentesis in this type of case with recovery of blood is frequently the early motivating factor for prompt laparotomy. Thompson and Brown [2] have reported submitting "many patients" to laparotomy with minimal or no evidence of abdominal injury other than positive tap. They did, however, report on one patient who was stuporous due to an injury to the head. Repeated needle aspiration revealed partially clotting blood from the right lower quadrant of the abdomen. Subsequent laparotomy revealed three needle holes in a very low right lobe of the liver extending to the iliac crest. Thus an unnecessary laparotomy was performed. These authors also stated that of the patients in this group who had minimal or no evidence of abdominal injury and had a negative tap, none was found later to have any major abdominal pathologic condition.

Ruptured urinary bladder has been diagnosed by the uriniferous odor of the fluid [6]. Findings in rupture of other hollow viscera will, of course, vary with the amount of fecal spillage and the presence or absence of peritonitis. Within a few hours a foul odor should be the rule.

It is to be stressed that in each and every situation when abdominal paracentesis is employed, although a positive aspiration may make or confirm the diagnosis, a negative tap by no means of itself excludes intraperitoneal disease.

## CASE REPORTS

CASE I. O. L. A., a fifty-seven year old white man, was admitted on January 9, 1952, with jaundice and hepatomegaly of unknown etiology. After preliminary studies a diagnostic peritoneoscopy was performed on January 23rd, at which time needle biopsy of the liver was done. The pathologic report was cholangiolitic hepatitis. Following this procedure abdominal distention, nausea, vomiting and shock developed. Bile-stained ascitic fluid was obtained by paracentesis. A diagnosis of bile peritonitis was made and the patient was operated upon using field block anesthesia. Bile was found to be leaking from the biopsy site in the liver. The leak was repaired, cholecystostomy was performed and the abdomen was closed. The patient's general condition was desperate during this procedure but he slowly recovered and underwent Whipple's operation on March 17th for carcinoma of the ampulla of Vater.

*Comment.* This case is significant in that aspiration of bile-stained abdominal fluid revealed bile peritonitis secondary to needle biopsy of the liver. The timely laparotomy probably saved this patient's life. It is interesting to note that he is now living and well, apparently free of disease, three and a half years later.

CASE II. C. J. B., a thirty-six year old white man, was admitted at 9 P.M. on February 19, 1955. At 9 A.M. on the day of admission, approximately twenty minutes after he had eaten breakfast, sudden acute pain developed in the left lower anterior chest; the pain was non-radiating and was accentuated by deep breathing. A few moments following this episode he "blacked out" for a moment and experienced two similar episodes within the hour. The pain was relieved following the last "blackout." There was no nausea, vomiting or abdominal discomfort. Four weeks prior to admission he had been in an automobile accident and had sustained a contusion to the chest anteriorly, but there had been no apparent evidence of serious damage. Subsequently he had been in good health until onset of the present illness. The patient appeared listless and apprehensive. The pulse rate was 90, blood pressure 120/84. There was slight tenderness of the left chest border anteriorly and moderate guarding in the epigastrium. Abdominal pressure produced mild pain in the substernal area. Peristalsis was normal. The admission blood count was 4.4 million red blood cells with 12½ gm. per cent hemoglobin and 40 per cent hematocrit. Serum amylase was 50 Somogyi units. The white blood cell count was 23,000

with a shift to the left. X-rays of the chest and abdomen were negative for any abnormalities, as was an emergency electrocardiogram. At the time of admission cardiac contusion or myocardial infarction was the primary consideration. Paracentesis was performed to exclude the remote possibility of ruptured spleen or other abdominal injury. This yielded bright red blood which failed to clot. Splenectomy was performed for ruptured spleen. The postoperative course was uneventful.

*Comment.* This patient did not portray evidence of any abdominal emergency on admission. Without paracentesis he would doubtless have continued to bleed and possibly would have gone into shock before diagnosis and surgical intervention.

CASE III. C. T. S., a fifty-nine year old white man, was admitted on November 8, 1952, complaining of severe generalized pain. For six months he had been having intermittent abdominal pain and fullness, at times relieved by food and alkalis. He had had a particularly severe attack of pain in the upper abdomen on the day of admission and had suddenly become weak and perspired freely. Physical examination revealed a moderately obese, pale white man appearing acutely ill. The abdomen was distended and presented generalized tenderness and rebound tenderness, most marked in the right lower quadrant and epigastrium. Diffuse abdominal guarding was present but there was no definite rigidity. No peristalsis was heard. The leukocytes showed a shift to the left but no elevation. The red blood cell count was normal; the serum amylase was 480 Somogyi units. (We consider 300 or more units to be definitely abnormal.) Films of the chest and abdomen showed no abnormalities. A difficult decision had to be made in the diagnosis between pancreatitis and perforated ulcer. Abdominal paracentesis was performed with removal of thin, greyish white, mucoid fluid containing bile. The amylase level on this fluid was 203.5 Somogyi units. Diagnosis of perforated ulcer was then made and the patient was taken to surgery where closure of a perforated duodenal ulcer was performed. His postoperative course was quite stormy, with gradual improvement.

*Comment.* In this case paracentesis established the diagnosis of perforated ulcer and called for timely surgery.

CASE IV. R. C. H., a forty year old white man, was admitted to the Medical Service on July 16, 1953. He stated he had been well until July 10th, at which time he had experienced episodes of severe nausea and vomiting. This continued and he tried to alleviate his symptoms by drinking gin and beer. This was followed by a sudden episode of epigastric pain described as a constant soreness. The pain spread to the periumbilical region and then became generalized and finally subsided, only to recur the morning of admission. On examination the patient's abdomen was soft with mild generalized tenderness, guarding and spasm. There was no localized tenderness and no rebound tenderness. The red blood cell count was 5.9 million with 16½ gm. per cent hemoglobin. The white blood cell count was 20,200, with a shift to the left. Serum amylase on admission was 320 Somogyi units. The patient was considered to have alcoholic gastritis or perhaps an exacerbation of diverticulitis. He was given intravenous fluids and sedation. His abdominal pain increased and surgical consultation was obtained. There was moderate abdominal tenderness and guarding in both lower quadrants. X-rays of the abdomen and chest were non-contributory. Abdominal paracentesis was performed and a blood sample was drawn. Amylase determinations were procured on both specimens. These revealed a level of 4,120 units on the abdominal fluid and 278 units on the serum. Bilateral splanchnic blocks were performed, with marked relief of pain. The patient was continued on medical management and recovered from this attack.

*Comment.* Abdominal paracentesis in this case furnished the final conclusive evidence for pancreatitis and excluded other seriously considered diagnoses such as perforated ulcer and ruptured appendix. It should also be pointed out that the amylase level of the abdominal fluid was still quite elevated while the serum level had returned to normal.

CASE V. J. J. S., a thirty-four year old white man, was admitted on March 4, 1955, complaining of severe upper abdominal pain, the fourth episode since mid-November, 1954. The pain had begun in the back and had radiated anteriorly to both sides of the mid-abdomen. The present episode started approximately four days prior to admission, with

gradually increasing intensity. Nausea and vomiting had been present but not just prior to admission. The patient was a moderately heavy user of alcohol. Physical examination revealed a well developed, slightly obese white man complaining of severe abdominal pain and requesting narcotics. There was moderately severe tenderness in the costovertebral angle areas bilaterally. There was generalized moderate abdominal tenderness and rebound tenderness. The liver edge was palpable 2 fingerbreadths below the right costal margin. The white blood cell count was 17,050; the serum amylase was 354.2 Somogyi units. Gastric washings were positive for acid-fast bacilli. Chest film on admission showed some infiltration in the left first interspace. Upper gastrointestinal series showed a deformed duodenal cap with the second portion of the duodenum being rather spastic and contracted. Abdominal paracentesis was performed on the right side and less than 1 cc. of thick, turbid, grey fluid was obtained which revealed varied types of bacteria with pus cells. Paracentesis was then repeated on the opposite side and 50 cc. of slightly cloudy, yellow fluid were easily withdrawn. This gave an amylase reaction of 930 units. The patient was treated medically for the pancreatitis. There was gradual improvement and he was subsequently transferred to the medical service for treatment of pulmonary tuberculosis.

*Comment.* This case illustrates the advisability of a bilateral tap when a negative or confusing tap has been obtained on the first side. This procedure confirmed the diagnosis of pancreatitis and obviated laparotomy in this patient who had active tuberculosis.

Case VI. J. B. T., a fifty-seven year old Negro man, was admitted on January 12, 1953. He complained of intermittent episodes of bloating, loss of appetite and abdominal distress of over two years' duration; these had been more frequent in the four weeks prior to admission. The patient appeared in moderate distress. The scleras were slightly icteric and there was abdominal protuberance with shifting dullness. There was tenderness in the epigastric region with a suggestion of a mass extending from the stomach region to the right upper quadrant. The liver, kidneys and spleen were not palpable. Red blood cells numbered 3.7 million with 12 gm. per cent hemoglobin. The white blood cell count was 11,400. Serum bilirubin was 1.2 mg. per cent. Ascitic fluid from abdominal paracentesis revealed the presence of carcinoma cells. Subsequent needle biopsy of the liver confirmed the diagnosis.

*Comment.* This patient was spared an exploratory laparotomy by paracentesis and later by needle biopsy of the liver. Autopsy revealed carcinoma of the tail of the pancreas with widespread metastases.

## CONCLUSION

It is surprising that the recent medical literature, especially that used in teaching, makes little reference to paracentesis as a method of diagnosis. We believe that abdominal paracentesis is a useful procedure in the conditions described and should be incorporated among the usual diagnostic procedures. It is much safer than thoracic paracentesis, a performance which is carried out widely without serious regard. In addition to its diagnostic value it also frequently may avert unnecessary laparotomy, as in cases in which the procedure aids in making the diagnosis of acute pancreatitis or primary peritonitis. Finally, we must caution that although positive findings may make the diagnosis, a negative tap should never exclude the possibility of fluid in the abdomen or alter conclusions derived from other clinical evidence.

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# Acute Surgical Conditions of the Abdomen

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DESPITE the great medical advances of the past two decades the problem of diagnosis of the acute surgical condition of the abdomen may still be baffling. Our mastery of surgical technic has reached a high level; anesthesia is now relatively safe; adequate blood is available; our knowledge of fluid and electrolyte balance has increased; antibiotics are used to protect against infection. Unfortunately our diagnostic ability has not progressed at the same pace. To improve this state, frequent and searching consideration of the value of diagnostic procedures is indicated.

Although acute surgical conditions of the abdomen may be due to trauma, this etiologic factor will be eliminated here for the sake of brevity. While traumatic cases may present problems in finer diagnosis, commonly the indications for treatment are quite definite; if this is not so, such cases can be considered on the same basis as the non-traumatic case.

Perhaps it will help to clarify our thinking if the conditions were divided into four general groups: acute inflammatory lesions, acute perforations, obstructive lesions and hemorrhagic lesions.

## DIAGNOSTIC PROCEDURES

### *History*

In the study of the patient suspected of having an acute surgical condition of the abdomen the history is of great importance. Thirty years ago the average method of diagnosis in cases of abdominal pain entailed little history-taking. The physician would press about the patient's abdomen; and if this revealed tenderness, he would advise immediate surgery. We have come a long way since that era. It is usually wise to allow a patient to tell his story with little interference. After he has finished, he should be questioned to clear up any doubtful points. We do want to know how the present attack started and which symptoms appeared first, such as pain, vomiting or chills. Next we must know what other symptoms developed and in what order they appeared. The duration of the present attack is important. Symptoms may change after a few hours; hence, at the time of examination they may be quite different from those present at the onset. We know that most conditions requiring surgery follow a rather definite pattern. As a general rule, acute appendicitis begins with a diffuse, colicky type of pain perhaps in the epigastrium, localizing in the right lower quadrant as a steady type of pain after a few hours. In perforated ulcer the pain is usually localized in the upper part of the abdomen at first; however, in a few hours, after the stomach contents have passed down the right lumbar gutter, the pain is felt in the right lower quadrant. Patients whose abdominal symptoms are due to a coronary attack or an acute pneumonic process frequently complain of upper abdominal pain at first. Few of the acute abdominal conditions, except those due to trauma, occur without some previous warning, so that a careful review of the past history will usually be rewarding. We must know if the patient has ever suffered similar attacks. The history of the various systems should be reviewed to avoid overlooking any important points. Too often the patient will answer questions negatively, and it is only by careful probing that we secure significant details. We should know if the patient has received blood or plasma within the past few months. It is wise to ascertain if he has taken antibiotics recently, for these may well mask symptoms and signs. We should ask if any other members of his family have had similar illnesses recently. The patient should also

be questioned about the condition of his stomach and bowels, the presence of tarry stools, icterus, weight loss and other symptoms.

The age and sex of the patient may prove helpful in pinpointing the condition, for we know that certain conditions such as acute appendicitis, pyelitis and intussusception are more common in children. Appendicitis, strangulated hernia, acute cholecystitis, pancreatitis and perforated ulcer are commonly found in adults.

### *Methods of Diagnosis*

In evaluating the acute condition of the abdomen several symptoms and signs are of major importance, and careful attention to them may point to the diagnosis. They are pain, vomiting, tenderness and rigidity; the patient's temperature, pulse, respiratory rate and blood pressure should be watched.

The onset of pain is usually sudden; it may begin in a mild fashion but can be quite severe if there is sudden and widespread peritoneal irritation as in perforated ulcer. The most common site of onset of pain is in the region of the umbilicus; later the pain may localize in the area over the offending organ. It is often difficult for an examiner to evaluate the intensity of pain completely. Patients vary greatly in their response to pain. The stoic with the board-like abdomen may not say much about his pain, whereas the high-strung patient may complain bitterly about some gas. The examiner will want to know the present location of the pain and if it has changed location since the onset. Also he will question if and where the pain radiates. We should not forget that in biliary colic the pain may be located quite high up in the right chest or in the left upper quadrant of the abdomen and that it is often referred to the right shoulder region. The patient with the colicky pain doubles up and rolls about with the spasms; the patient with a steady pain remains in a fixed position often with the knees drawn up and turned to the side. Pain is probably the most important and constant symptom of acute abdominal disease. In general it can be said that the persistence of abdominal pain for more than six hours in a person previously well, if accompanied with vomiting or a rising pulse rate or temperature, is indicative of an acute surgical condition of the abdomen.

Pain arising in a diseased intra-abdominal organ is usually reflected to the overlying area of the abdominal wall but may be reflected to a more distant site. A given segment of the spinal cord supplies peripheral somatic nerves of motion and sensation to a specific surface area or dermatome; this cord segment also has associated with it certain autonomic nerves. Each organ of the body has certain autonomic nerves carrying impulses between that organ and a given segment of the spinal cord, so that impulses arising in a given viscus are carried by the autonomic fibers to the appropriate cord segment; these impulses are then referred through the somatic nerve fibers to a given skin area. In this fashion the so-called viscerosensory and visceromotor reflexes are mediated, resulting in pain, spasm, etc. In some instances the given dermatome is quite removed from the area in which the viscus is located; consequently pain may be felt in a more distant part. We have a good example of this in the pain referred to the shoulder from irritation of the diaphragm. As is known, in the embryo, the anlage of the diaphragm first appears high in the cervical region and its nerve supply is from C4, 5 and 6; later, as the diaphragm descends, it carries this same nerve supply with it. An opposite situation is also quite common, in which painful stimuli arising in an organ outside the abdomen gives rise to abdominal pain. Consider the heart: Here we find interlocking pathways between splanchnic and cardiac nerves. They are related to the same or contiguous cord segments. The preganglionic fibers of the cardiac nerves (superior, middle and inferior) arise in the upper five dorsal segments of the spinal cord. The splanchnic (sympathetic) nerves arise from ganglia in relation to the lower segments of the spinal cord, the greater splanchnic nerve being thus related to the fifth to ninth segments of the dorsal cord. Therefore, with the cardiac and splanchnic nerves so intimately associated at the level of $D_5$, it is easy to appreciate how impulses originating in the heart may be referred to the abdomen.

Vomiting is usually present in most serious acute abdominal conditions. The vomiting may be cerebral in origin, reflex or due to local causes. The vomiting center is located in the medulla near the dorsal nucleus of the vagus nerve. This center may be excited by reflex impulses originating in the gastrointestinal

tract or other parts of the body. Impulses from the higher cerebral centers may stimulate it and certain chemicals carried to the center by the blood stream may activate it. Vomiting commonly appears after the onset of pain. It may continue almost constantly or may occur at intervals; it may cease shortly after the onset. The absence of vomiting must not be taken as a good omen in all instances, however, for we have all seen patients with serious acute abdominal conditions who did not vomit. True fecal vomiting is rare but feces-like vomiting is not uncommon, especially in low obstructions of the small bowel. Usually the ileocecal valve prevents regurgitation of fecal material into the ileum.

The patient with pyloric obstruction and gastric dilatation often vomits large quantities, after which the vomiting ceases for a considerable period. Vomiting with obstruction of the upper small intestine is often constant and profuse. Vomiting due to obstruction of the large bowel occurs later and is not so profuse. The examiner will want to know how much the patient did vomit, for some patients tend to exaggerate this symptom. The absence of bile in the vomitus suggests pyloric obstruction. The presence of blood is important. The odor of the vomitus may suggest acidosis or uremia. Relief after vomiting a large volume of material suggests pyloric stenosis. Vomiting that is purely reflex soon ceases. If vomiting is accompanied with colicky pains, the vomiting generally occurs with the spasms.

Careful inquiry into the activity of the bowels may prove quite enlightening. Constipation is the rule when there are acute inflammatory processes in the peritoneal cavity. However, this may be influenced by cathartics taken at the onset. In high intestinal obstructions the patient may have one or more apparently normal bowel movements after the onset of the disease. Although constipation is the rule in acute appendicitis, we must remember that in approximately 10 per cent of cases there is a diarrhea. A history of bloody stools suggests tumor, diverticulitis, ileitis, mesenteric thrombosis, intussusception or ulcerative colitis. Tenesmus is often associated with pelvic abscesses due to a perforated appendix or pelvic inflammatory disease or acute diverticulitis. The question of passing gas assumes considerable importance if there are no stools. Many patients with an acute process in the abdomen describe the sensation that their bowels are stopped and believe that if they could have a passage, they would be relieved. In the chronic condition any change in bowel habits merits careful attention to the colon or rectum for tumor.

On primary examination many of us tend to focus our attention on the abdomen, yet it is wise to remember that the abdomen is only a part of the body. First a quick general examination should be made. Often a great deal of information can be secured from the general appearance of the patient. Does he seem anxious or in pain? Is he having respiratory difficulty as evidenced by flaring of the alae nasi? Is there normal luster to the eyes or do they appear sunken? The condition of the tongue should be noted. At one time physicians placed great importance on the appearance of the tongue, yet we more laboratory-minded doctors of today often forget it. The clean, moist tongue is not usually seen with serious abdominal conditions. The apparent mental status of the patient is evaluated. We note if the skin is hot and dry or cool and moist, and should observe if it is pale or flushed, icteric or cyanotic. It is always wise to examine the neck and axillas for nodes. Such a finding may be indicative of Hodgkin's disease, leukemia or infectious mononucleosis. Search for Virchow's node above the left clavicle should also be made. The heart and lungs should be eliminated as possible sources of the abdominal complaints. Even though the gastric crisis of tabes dorsalis is now uncommon, the pupillary and knee reflexes should be tested. The legs should be inspected for swelling and redness. The genitalia must not be overlooked.

The rate and volume of the pulse provides information of value. There are instances of severe abdominal lesions in which there is little change in the pulse for several hours; however, these situations are uncommon. Pulse readings every few minutes will yield helpful data. A pulse rate higher than the temperature in proportion is commonly a bad omen. The slow pulse noted in hepatic disease is not always present.

There is no significant rise in temperature during the first few hours after the onset of most acute abdominal conditions, after four to six hours, however, there is a definite elevation. A sharp rise of the temperature to 102°F. or more occurring soon after onset of illness sug-

gests that the lesion is not within the abdomen. A subnormal temperature suggests shock, severe hemorrhage or overwhelming infection. Chills and fever suggest invasion of the blood stream by bacteria.

Changes in the frequency and depth of respirations may be significant. In peritonitis breathing is restricted to the chest, whereas in lesions above the diaphragm there is not usually an absence of abdominal movements. Retraction of the intercostal spaces is indicative of marked respiratory difficulty. If the respiratory rate is about twice normal at the onset of the disease, the lesion is probably in the chest. Normally the ratio between pulse and respirations is approximately 4:1. In lesions of the chest this ratio is usually less than 3:1, whereas in abdominal lesions it is greater than 4:1. The patient's breath may be informative, as the sweet breath of acidosis and the foul breath of uremia are quite characteristic. Imminent shock is often foretold by a drop in the blood pressure before there are other notable signs.

Observation of the abdomen in a good light will often yield valuable information. The size, shape, contour or presence of dilated veins, tumor masses, hernias, etc., should be noted. Does the abdomen seem distended? Does it seem to spill over at the sides as if fluid were present? Does the abdomen move with breathing? Are coils or peristaltic waves visible? These are only a few of the questions which the examiner should ask himself.

Auscultation is a valuable aid in examining the abdomen. It should be done before palpation and must be done patiently, listening in each of the quadrants. Normally peristaltic sounds have approximately the same frequency as the respiratory rate. The silent abdomen generally indicates diffuse peritonitis. Hyperperistalsis may be indicative of the early stages of an obstruction or enteritis. One soon learns to recognize the high-pitched tinkling sound of peristaltic waves when the bowel is dilated, and the rushes of the hyperactive bowel as opposed to the quiet clicks of normal peristalsis.

Some degree of tenderness is usually present when an acute surgical lesion of the abdomen exists. Superficial tenderness, actually cutaneous hyperesthesia, is not always significant. Deep tenderness, however, is of much more importance. It is commonly found over the site of the involved organ; but if diffuse peritonitis exists, it is pretty widespread. Rebound tenderness probably has little more significance than deep tenderness; at times it may be misleading. Palpation must always be gentle but deep. It is well to begin palpating the abdomen far away from the suspected site. If the patient is having colicky pains, palpation between the bouts of pain is more revealing. Voluntary resistance to palpation may be overcome to a large degree by having the patient flex the lower extremities and take deep breaths. If a mass is felt, we must determine its approximate location, its mobility, size, if it pulsates, etc. The hernial orifices must be examined carefully. We should search for a dilated stomach, cecum or intestinal coils, and for a full bladder.

Spasm and rigidity are usually present in varying degrees when there is an acute surgical condition of an abdomen. Absence of spasm and rigidity suggests that the pathologic condition is outside of the abdomen. Voluntary spasm of the abdominal muscles is a frequent finding and is not too significant; this usually can be eliminated by distracting the attention of the patient. Involuntary spasm is more significant, however, and usually indicates the presence of disease. The extent of spasm will vary greatly, depending on the nature and location of the disease.

Percussion will yield much information. By this technic we can determine if there are abnormal areas of dullness or tympany. The size of the liver or spleen, the presence of gas outside the bowel, the existence of free fluid, dilated bowel, etc., can be demonstrated.

Rectal examination should be a part of every physical examination. This is frequently neglected, especially when the condition seems to be present in the upper abdomen. The absence of feces in the rectum may be important. The presence of either bright red blood or a tarry stool is determined. We look for tumor of, or outside, the rectal wall or if the rectal wall is thickened and edematous as occurs with pelvic infections, diverticulitis below the peritoneal reflection, etc. Sigmoidoscopic examination should be made on the slightest provocation.

A bimanual examination should be done routinely, also, on most women. The size, consistency and position of the cervix and fundus should be determined. We should note if pressure on the cervix causes pain. A careful search for a pelvic mass should be made.

Usually help can be obtained from the laboratory. In many university hospitals it is common practice to throw the laboratory manual at most patients. This is often wasteful of time and money and sometimes unrewarding also. A few laboratory tests are essential. The routine urinalysis is basic. A complete blood cell count is of value. The white blood cell count and differential can help in distinguishing between an acute surgical process and a non-surgical condition; it may help to avoid operating upon the patient with leukemia, mononucleosis, etc. The red blood cell count will show whether or not the patient has anemia, and check of the hemoglobin may help to distinguish between primary or secondary anemia. A red blood cell count cannot be expected to reflect an acute blood loss promptly. In this connection probably the hematocrit gives a more realistic impression. Next in importance I consider the non-protein nitrogen or blood urea nitrogen and the blood sugar determinations. The uremic patient may present signs suggesting an acute condition of the abdomen, as does the diabetic patient whose condition is out of control. The latter patient may even have a leukocyte count of 20,000 or more. These tests also help in evaluating the surgical risk and indicate the need for special pre- and postoperative care. In certain cases the serum protein with the albumin-globulin ratio may be helpful in determining hypoproteinemia, anemia, disease of the liver, etc. In the cases of diseased liver the cephalin flocculation or the thymol turbidity test should be made. In many cases of upper abdominal disease the serum amylase and lipase determinations may be indicated. It is almost routine with me to have a prothrombin time done to indicate possible liver dysfunction or need for vitamin K. In the occasional case carbon dioxide estimation will prove helpful. Rarely in the acute case is determination of the sodium, potassium, chlorides, etc., of much value; these are important postoperatively in the patient who is on parenteral feeding for more than three to four days.

As referred to elsewhere, the blood volume determination by the Evans blue dye test or by isotopes is so time-consuming and subject to so much error that it is generally not useful in the acute case. Uusally the clinical estimate, as determined by observation of the patient, the vital signs, the blood counts or hematocrit readings and the obvious loss of blood provide a realistic evaluation of acute blood loss.

X-ray examination may be helpful in many cases of acute surgical condition of the abdomen. Films of the chest may reveal unsuspected conditions which could cause reflex abdominal symptoms or which would interdict surgery. The scout film of the abdomen may show a greatly dilated stomach, for which surgery has occasionally been performed. The flat plate may reveal a markedly dilated cecum or sigmoid, suggesting a volvulus, or it may reveal free gas. If the patient can sit up, films in this position are more helpful to ascertain free gas under the diaphragm. Films in the lateral projection with the patient in the decubitus position may show fluid or gas levels. Intestinal obstruction can usually be diagnosed by x-ray examination. In examining films of the abdomen we should keep in mind that it is not usual to find gas in the small bowel of the adult, but this finding is common in children. Occasionally we will find a gallstone or kidney stones which were unsuspected and could be causing the symptoms. The finding of a calcified pancreas may suggest the possibility of acute pancreatitis. Perhaps an intravenous pyelogram may be indicated to eliminate the suspicion of a renal or ureteral lesion. In the case of trauma the intravenous pyelogram will often reveal a torn kidney or a ruptured bladder. Occasionally we request emergency study of the stomach with a small amount of thin barium to see if there is an ulcer that could be the cause of bleeding; at the same time esophageal varices may be discovered.

In some cases aspiration of the peritoneum may yield diagnostic findings such as blood or pus.

### DIAGNOSIS

Patients with acute abdominal symptoms can be divided into three groups. The first group consists of those patients with definite indications for surgery. The second group is made up of those whom we are sure do not require surgery. The third or in-between group is the one which gives us most of our problems. In dealing with patients in this group so many surgeons operate for fear the patient might have some undiscovered or overlooked condition. Many of these exploratory operations disclose nothing significant. Actually, in most instances there is little need to perform imme-

diate abdominal surgery. A few additional hours spent in observation of the patient will usually enable one to arrive at a more definite diagnosis. During this time certain laboratory studies can be made and some therapy instituted. I realize fully that in the past two decades the indications for surgery have been broadened, and some of this is justifiable. However, there is no excuse for the performance of surgery merely because it can be done with reasonable safety unless we honestly believe the patient will be benefited by it.

In attempting to arrive at a definite diagnosis this rule has stood me in good stead: A valuation of 33⅓ per cent is placed on the history; a similar credit is alloted to the physical findings and another 33⅓ per cent to the laboratory results. A typical history would allot 33⅓ per cent toward the diagnosis, whereas an atypical history might value only 10 per cent. The physical findings and laboratory data are evaluated in the same manner. If the sum of these is not greater than 50 per cent, the diagnosis is probably in error; if the sum is 75 per cent or more, this would seem to indicate the correct diagnosis.

Myocardial infarction often causes abdominal symptoms which in some instances are difficult to evaluate correctly. This condition may be confused with any of the common acute surgical conditions of the upper abdomen. Generally, however, there is a previous history of coronary insufficiency or prior infarctions. The coronary insufficiency usually occurs with substernal distress and perhaps with indigestion, followed with pain in the chest with radiation to the arm. The indigestion may suggest an abdominal condition; in fact, one physician treated his "indigestion" for twenty-four hours before he realized he was having a coronary episode. In the first few hours the picture may be very confusing; after a time, however, the abdominal signs tend to diminish. Generally the appearance of the patient, the finding of elevated pulse and respiratory rates as well as a lowered blood pressure, and perhaps electrocardiography will help resolve the diagnosis. It should be made clear, however, that a negative electrocardiogram does not rule out a coronary episode in the earlier stages.

In like manner, acute pericarditis with effusion is occasionally confused with a surgical condition of the abdomen but ordinarily the diagnosis can be cleared by x-ray and electrocardiographic examinations.

A pneumonic process tends to begin with chills and high fever. There are usually cough and pain in the chest. The vital signs are those of a lesion of the chest and not those of an abdominal condition. Commonly the physical findings are diagnostic even though an early radiograph may be equivocal.

### CAUSATIVE DISEASES

A listing of the relative frequency of the diseases that commonly give rise to the acute surgical condition of the abdomen should prove helpful. In any large series of cases the incidence will be approximately as follows: acute appendicitis, 45 per cent; acute pelvic inflammatory disease, 24 per cent; acute intestinal obstruction, 13 per cent; acute cholecystitis, 6 per cent; acute massive bleeding from the upper gastrointestinal tract 5 per cent; acute pancreatitis, 3 per cent; perforated peptic ulcer, 3 per cent.

*Acute Appendicitis.* The typical history of an acute attack of appendicitis is well known. The periumbilical pain, crampy in nature, accompanied with nausea and vomiting, localizes in the right lower quadrant of the abdomen in a few hours; it is accompanied with spasm and rigidity, and usually absence of peristalsis. The pelvic appendix in the female may present symptoms suggesting pelvic disease, while the high-lying retrocecal appendix may present symptoms simulating a lesion of the urinary tract. Although constipation is the rule in acute appendicitis, diarrhea is associated with acute appendicitis in approximately 10 per cent of cases. We must always keep in mind that the symptoms may be obscured if the patient has recently had antibiotics. The differential diagnosis is not always easy, especially in the early stages. One frequently sees an adult patient with a scar from McBurney's incision who is having an attack of right-sided ureteral colic. When dealing with this problem, it has long been my practice to order an intravenous pyelogram or even request a cystoscopy and ureteral catherization by the urologist. This will occasionally avoid the removal of a normal appendix. In children right-sided pyelitis may be confusing. Usually with this condition there is a higher fever and a higher white blood cell count, as well as a

tenderness of the kidney area. Mesenteric adenitis is frequently a stumbling block. Usually here we have a history of an acute upper respiratory infection, and the history of the abdominal complaints is atypical for acute appendicitis. Generally the physical findings are much less marked in patients with adenitis. In women, salpingitis may confuse the examiner, but generally there is a history of vaginal discharge and the onset of the abdominal symptoms occurs during the later stage of a menstrual period. The symptoms and findings are bilateral. Movement of the cervix uteri causes pain in the patient with pelvic inflammatory disease. Commonly the white blood cell count is higher in this condition than in acute appendicitis. The bleeding graafian follicle is quite frequently mistaken for acute appendicitis. Usually the bleeding occurs midway between menstrual periods; often there is little or no nausea, the pain is commonly less and peristalsis tends to be about normal. A leaking ectopic pregnancy may confuse the examiner. Here there is usually a history of a missed period; the shock symptoms are greater than with appendicitis. Occasionally a perforated peptic ulcer with drainage down the right lumbar gutter may seem to be acute appendicitis; generally, however, there is an ulcer history and the patient seems more ill. I have been misled several times by a low-lying, acutely inflamed gallbladder. The so-called virus infection of the gastrointestinal tract may cause confusion but the failure of the pains to localize in a few hours and the presence of diarrhea and the low blood count help toward a decision. Finally it is wide to remember that in the early stages many conditions such as poliomyelitis, acute rheumatic fever, some of the exanthemata etc. may cause acute abdominal symptoms.

*Acute Pelvic Inflammatory Disease.* Acute pelvic inflammation does not seem as common as it was prior to the use of sulfa drugs and antibiotics. The symptoms are usually milder than those found in some of the other acute abdominal conditions. There is commonly a history of some vaginal discharge, and the onset of the acute stage is related to the menstrual period. Nausea and vomiting are not very marked; distention is moderate; the pain and tenderness are located in the lower abdomen on both sides. The fever is often quite high for the first few days and the leukocyte count is notably elevated. On pelvic examination there is tenderness on both sides and pain with movement of the cervix.

*Acute Intestinal Obstruction.* The classic signs are nausea, vomiting and obstipation. These are accompanied with crampy pains. It is wise to recall that strangulated external hernias cause some 45 per cent of acute obstructions, indicating the need for careful examination of all hernial orifices. Femoral hernias seem to be overlooked most frequently. Approximately 30 per cent of acute intestinal obstructions result from adhesions or bands, so that an abdominal scar may be of considerable significance. In children bloody stools suggest intussusception, whereas in adults mesenteric occlusion or intussusception should be considered. The abdomen may show coils or patterns when the process is fully developed. X-ray examination will usually make the diagnosis and sometimes not only localize the site but also indicate the cause. One word of caution seems in order. The finding of dilated loops of bowel by radiography should not be the sole indication for surgery. In many conditions such as pneumonia, terminal uremia, acute calculous pyelonephrosis, the films may indicate an ileus. Differentiation between a simple and a strangulating obstruction is not always facile. Of course in strangulating obstruction we do not expect the symptoms to be more marked; usually the patient's temperature is elevated and the white blood cell count rises. I have come to believe that if the patient suspected of having simple intestinal obstruction does not show clinical and radiographic improvement after several hours of suction and enemas, exploration should be done.

*Acute Cholecystitis.* In this condition there is usually a long history of gas or indigestion and fat intolerance; there may have been prior attacks of colic with or without episodes of icterus. Vomiting is quite common at the onset but usually ceases within twenty-four hours. There is often no disturbance of bowel function. The temperature is usually not elevated significantly unless gangrene ensues. The serum bilirubin may be elevated. The leukocyte count is increased. A scout film of the abdomen may show stones. In the acute stage of gallbladder disease visualization is usually not attempted, especially if there is icterus. I shall not enter into a discussion as to whether early or delayed operation is best. Occasionally the

symptoms of perforated peptic ulcer may simulate acute disease of the gallbladder, especially if the pain of the ulcer is colicky instead of the usual steady type. More commonly, however, the question of acute pancreatitis taxes our acumen. Here the serum amylase determination may be helpful. Also, a high-lying appendix may mislead the examiner but generally the history will help solve the problem, for acute appendicitis usually does have a fairly typical symptom pattern. As indicated before, the problem of the myocardial infarction can be real but a few hours' delay may easily solve the problem.

*Acute Massive Hemorrhage from the Upper Gastrointestinal Tract.* This condition may be a serious and acute surgical problem. There are a few basic facts that should always be kept in mind. The first of these is that vomiting of blood is usually due to a lesion above the ligament of Treitz. Rarely does a lesion of the ileum or large bowel cause hematemesis. On the contrary, the passage of bright blood by rectum is not necessarily an indication that the lesion is below the ligament of Treitz. Bleeding in large quantities from a peptic ulcer may cause hyperperistalsis and so result in the passage of bright blood by rectum. Next we have to consider the relative incidence of lesions causing hematemesis. Benign peptic ulcer probably causes such bleeding in approximately 65 per cent of cases. We recognize that esophageal varices are a source of bleeding in approximately 10 per cent. Most of us overlook the fact that acute gastritis or hemorrhagic gastritis does cause massive bleeding in 10 to 15 per cent of cases. The less common causes such as hiatus hernia, tumors, etc., must be eliminated. We must be quite definite in what we call massive bleeding. If the red blood cell count is below 3 million and the hemoglobin below 50 per cent, or the patient requires more than 1,500 ml. of blood in twenty-four hours to maintain balance, we can call bleeding massive.

There has been a wave of surgical enthusiasm in the treatment of such cases. Recently I note that a more careful appraisal of the results seemingly indicates the need for a more cautious attitude. Certainly the patient is entitled to the benefit of surgery if he has a known peptic ulcer and is having massive bleeding. Whether or not we should subject the patient to subtotal gastrectomy in cases of acute gastritis, etc., is a moot question. Recently some of us, after exploring the mucosa of the stomach through a generous opening and finding diffuse bleeding, have simply closed the abdomen and have utilized the quiet treatment, in several instances with no regrets.

*Acute Pancreatitis.* The patient with acute pancreatitis is usually well nourished and often obese. The acute onset usually follows a very good meal and/or the taking of considerable alcohol. There is severe upper abdominal pain with continuous retching. Bowel sounds are absent. There is marked spasm and tenderness of the upper abdomen and later a feeling of tumefaction is noted. The temperature may be subnormal in the earlier stages. The pulse is elevated and often of small volume with a low pressure. In the most severe cases there is cyanosis due to impending circulatory failure. A scout film of the abdomen may show calcification in the area of the pancreas, or gallstones, or nothing abnormal. Commonly the leukocyte count is elevated. In the first twenty-four to forty-eight hours of the disease the serum amylase is often elevated significantly but it may be normal. It is generally appreciated that a low amylase does not eliminate the diagnosis. On the other hand, for years we have been placing great reliance upon the finding of a high serum amylase (over 500 Somogyi units). More recently, evidence has been accumulated which casts some suspicion on the diagnostic import of an elevated amylase. It has been found that the serum amylase may be markedly elevated in acute obstruction of the bowel, in some cases of perforated ulcer, in acute cholecystitis and following administration of opiates causing spasm of the sphincter of Oddi. In a recently reported series of cases in which there was marked elevation of the serum amylase it was found by operation or postmortem examination that acute pancreatitis was present in less than 50 per cent. In view of this it now seems reasonable to explore the patient in spite of the high amylase if the abdominal findings become the least bit uncertain or if the patient does not do well.

*Perforated Peptic Ulcer.* Usually in these cases we do obtain a history of indigestion or formal treatment for a suspected or known ulcer. The onset is sudden with severe and steady abdominal pain, usually with associated

vomiting. The patient is pale; he looks sick. The pulse is accelerated, whereas the temperature is subnormal and later tends to rise moderately. The abdomen is tense and tender, especially in the upper half; subsequently the entire abdomen is spastic. No peristalsis is heard. The white blood cell count will be mildly raised. X-ray examination may show free gas beneath the diaphragm, but a negative finding does not eliminate perforation. Perforation may be confused with acute pancreatitis. The history should give the clue and the x-ray and the amylase test will help. Differentiation from a myocardial infarction may be hard; if the signs are equivocal, suction of the stomach and parenteral fluids are recommended for several hours, by which time the situation will be less confused.

*Perforation of a Diverticulum of the Colon.* Diverticulitis of the colon with perforation usually results in acute diffuse peritonitis but may eventuate as a walled-off abscess. Commonly in this condition there is a history of increasing constipation and of minor attacks of left-sided abdominal pain. With perforation the signs are those of general peritonitis. X-ray examination may show free gas beneath the diaphragm. One of the problems encountered with acute diverticulitis is distinguishing it from carcinoma. Clinically this is often impossible. X-ray examination may help occasionally. Many times, however, with the abdomen open and the lesion in the surgeon's hand he is still not able to decide. Biopsy, unless positive, may be misleading. In such cases probably the only safe course is to perform limited resection and await the pathologic report.

Perforations of both the small and large bowel are occasionally caused by foreign bodies such as toothpicks, pins, spicules of bone, etc. Usually such perforations are walled off but occasionally lead to diffuse peritonitis. At times we do see a perforation resulting from complete intestinal obstruction due to tumor or other causes; here again, the signs are those of acute diffuse peritonitis.

*Regional Ileitis.* This condition may at times cause symptoms suggesting acute appendicitis. Almost one-half the patients with regional ileitis have undergone a recent appendectomy. In other instances the symptoms resemble those of enteritis but usually there is some blood in the watery stools. In some patients the symptoms resemble acute intestinal obstruction. The relatively long history of the patient should put the examiner on his guard. X-ray examination often leads to the diagnosis. Commonly secondary anemia is present with regional ileitis, and there may be leukocytosis. If operation is performed in such a case under the impression that the condition is acute appendicitis and an appendix is found which reveals no serious condition, it is well to inspect and palpate the terminal ileum, searching for the edematous thickening of the bowel walls and mesentery and the enlarged nodes.

*Mesenteric Occlusion.* This condition is not uncommon; it accounts for approximately 3 per cent of all cases of acute intestinal obstruction. The symptoms are often those of an acute surgical condition of the abdomen, with a considerable degree of shock. Often there are bloody stools. Whether the lesion is primarily arterial or venous is not important. If the patient has fibrillation, we should remember the possibility of a mural or valvular thrombus being swept into the systemic arterial circulation and lodging in one of the mesenteric arteries. If there is obvious thrombophlebitis of the veins in the leg or a failing heart, we would consider occlusion of one of the mesenteric veins.

*Dissecting Aneurysm of the Abdominal Aorta.* This condition is not always easy to diagnose. Here the basic condition such as hypertension or atherosclerosis is important. Frequently such patients are in severe shock because of the major leak; pain is intense. Usually the pain is not localized; it is often referred down the iliac arteries to the groins. Reflex retching and vomiting are marked. There is not much involuntary rigidity of the muscles of the abdomen. Often a mass can be felt which is expansile. Usually a bruit is heard. A scout x-ray film with fluoroscopy may prove very helpful. One should always remain alert to the possibility of such a condition.

*Eventration.* Eventration following surgery of the abdomen is a true surgical emergency. It usually occurs between the fifth and ninth postoperative days. I have seen several patients who had eventration through a greatly thinned-out old operative scar. Commonly the condition is seen in patients who are in a poor

state of nutrition and who have anemia; generally the eventration is preceded by continued abdominal distention, vomiting or coughing. The actual break-through of the skin is a sudden affair, but usually prior to this there is a gradual separation of the deeper layers of the abdominal wall. We have come to look upon a continuous serous discharge from an operative wound with suspicion. Also, we regard in the same light unexplained and continuing distention or vomiting. It has been my practice for a long time to obtain lateral films of such patients. These films will often reveal the entry of a loop of bowel into the tissues of the abdominal wall before actual dehiscence of the skin takes place. Usually patients with eventration are not too ill as a direct result of the complication.

## CONCLUSIONS

In most cases the so-called acute surgical condition of the abdomen presents no dire emergency. A delay of a few hours before operation may greatly benefit the patient. During this waiting period medical conditions can be evaluated, essential laboratory studies can be made and the patient's condition can be improved by the use of the duodenal tube, the administration of parenteral fluids or blood, and other conservative measures.

*We recommend:*

Ciba Foundation Colloquia on Endocrinology. Volume 9, Internal Secretions of the Pancreas. Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. 292 pages, 100 illustrations. Boston, 1956. Little, Brown & Co. *Price* $7.00.

Ciba Foundation Colloquia on Ageing. Volume 2, Aging in Transient Tissues. Edited by G. E. W. Wolstenholme and Elaine C. P. Millar, 263 pages, with 96 illustrations. Boston, 1956. Little, Brown & Co. *Price* $6.75.

Atlas of Exfoliative Cytology. Supplement 1. By George N. Papanicolaou, M.D., PH.D. Cambridge, Mass., 1956. Published for the Commonwealth Fund by Harvard University Press. *Price* $4.00. (New chapters as a supplement to the original book.)

A Manual of Oral Surgery. A Step-by-Step Atlas of Operative Techniques. By W. Harry Archer, M.A., D.D.S. Second edition, 877 pages, with 1,400 figures, with an index. Philadelphia, 1956. W. B. Saunders Co. *Price* $16.50.

# Hydronephrosis

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THIS is a review of one surgeon's experience with hydronephrosis, produced by means other than obstructing calculi, in a five-year period, January 1, 1951 to December 31, 1955. Although the Davis intubated ureterotomy [*1–6*], with minor variations, was the most commonly used conservative operation, no effort has been made to advance the cause of one procedure over others, but to assess results dispassionately. The following criteria were used: cured—absence of symptoms, pelvic residual and infection; improved—negligible symptoms, abatement of infection and a residual less than half the original in small hydronephrosis or under 25 cc. in large; failed—all others.

### URETEROPELVIC OBSTRUCTIONS

Twenty of the hydronephroses (62.5 per cent) were caused by ureteropelvic obstructions. They were found in persons ranging from six and a half to fifty years, the majority being between the ages of twenty and thirty years. Only three were women, attributable to the preponderance of men in the Armed Services. There were nineteen Caucasians and one Negro. Nine of the lesions were on the right side, a like number were on the left, and two were bilateral. The local lesions have been enumerated in Table I. To summarize, there were seventeen intrinsic strictures, eight ureteral kinks and seven vascular anomalies; in ten instances the obstruction resulted from multiple causes.

The pelvic residuals found at surgery ranged from 15 to 1,500 cc. In two instances it was less than 25 cc., in four between 25 and 50 cc., in five between 50 and 100 cc., in five between 100 and 250 cc., and there were four patients with residuals of 250 cc. or more; the mean for the twenty cases was 175 cc. plus. When the residual was under 100 cc., there was an almost equal distribution between intrarenal and extrarenal hydronephroses; above 100 cc. the hydronephroses were all of the mixed type. In four cases, two pinpoint intrinsic strictures and two elbow kinks, catheters could not be inserted into the renal pelves cystoscopically. Four cases were complicated by stones. Figures 1A and B illustrate a moderate-sized hydronephrosis of 125 cc.

TABLE I
ETIOLOGY OF HYDRONEPHROSIS

| Etiology | No. of Cases | Per cent |
|---|---|---|
| Ureteropelvic obstructions: | | |
| Intrinsic strictures alone | 8 | 62.5 |
| Intrinsic strictures and elbow kinks | 5 | |
| Intrinsic strictures and aberrant vessels | 1 | |
| Intrinsic strictures, aberrant vessels and elbow kinks | 2 | |
| Aberrant vessels alone | 2 | |
| Aberrant vessels and nests of adhesions | 1 | |
| Other vascular anomalies | 1 | |
| Ureterovesical obstruction: | | |
| Intramural strictures | 2 | 6.25 |
| Defects in innervation (megaloureter) | | |
| Terminating at pelvic brim | 1 | 6.25 |
| Terminating at ureterovesical junction | 1 | |
| Ectopic (pelvic) kidneys | 2 | 6.25 |
| Horseshoe kidney | 1 | 3.125 |
| Ectopic insertion of ureter in seminal vesicle | 1 | 3.125 |
| Unknown | 4 | 12.5 |

Twenty-five known surgical procedures were performed upon these patients, twenty-three by the author and two at other institutions. (Table II.) I performed nineteen intubated ureterotomies (three with stones), one division and transposition of the pelvis behind the renal artery (Case 1), one preliminary nephrostomy (Case IV), and one simple division of an aberrant vein in conjunction with removal of a stone. Nephrectomy was performed in one instance when a subcapsular tumor, a benign papillary adenoma, was discovered in a twenty-eight year old Negro man during surgery for

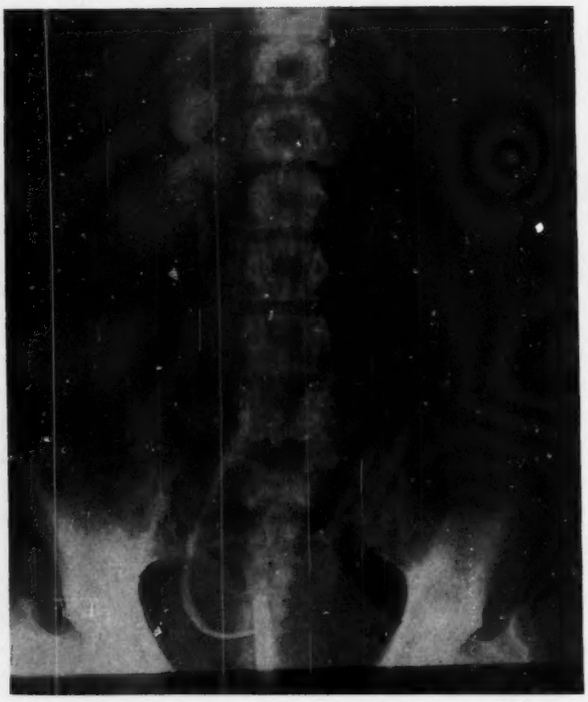

FIG. 1A. Preoperative ureteropyelogram in eighteen year old nulliparous white woman. At surgery on June 29, 1954, 125 cc. of residual urine were found caused by intrinsic structure.

FIG. 1B. Same case. Postoperative intravenous pyelogram taken one year later. Patient carried no residual and urine is sterile. Result: cured.

an intrinsic ureteral stricture. Elsewhere, one of my two patients termed "failures" (Case 1) underwent nephrectomy, and the other (Case II) underwent a Foley Y-plasty. Neither of the patients with bilateral lesions was operated upon on both sides. One was the patient in Case

TABLE II
RESULTS OF CONSERVATIVE SURGERY

| Operation | Cured (37%) | Improved (48%) | Failed (15%) |
|---|---|---|---|
| Intubated ureterotomy | 9 | 10 | 3 |
| Simple division of aberrant vessel | 1 | 0 | 0 |
| Pyelolithotomy | 0 | 2 | 0 |
| Division and transposition of pelvis behind renal artery | 0 | 0 | 1 |
| Resection of 12 cm. of distal ureter and reimplantation in bladder | 0 | 1 | 0 |

1; the other, a six and a half year old boy plagued with recurring infections all his life had so much improvement on the opposite side following correction of a right sided pinpoint, intrinsic stricture that it was decided to defer further surgery indefinitely.

Red rubber catheters were used as splints seventeen times; polyethylene tubing was used in four instances. The pelvis was drained through a pyelostomy twenty times and once by means of a nephrostomy. The splints were passed from the pelvis down into the bladder without the aid of an indwelling ureteral catheter, and in no instance did this prove impossible. The proximal ends of the splints were brought out the loin alongside the pyelostomy drains. These were the only significant variations from the standard Davis operation. No pelves were resected. Only twice was removal of the twelfth rib necessary. In the majority of cases all of the measurable urinary output came from the splint and pyelostomy tube for about forty-eight hours (indeed, this afforded assurance that the splint was in the bladder); thereafter, drainage from the splint was usually negligible. The nineteen ureterotomies took between one hour, thirty-seven minutes, and three hours, six minutes; the mean was slightly under two hours. An additional intubated ureterotomy was also performed because of an unusual surgical injury involving the ureteropelvic junction; this will be reported later [7].

Convalescence in six patients was complicated by one or more episodes of acute pyelonephritis which were never of grave conse-

quences (except in Case 1). The progress of the hydronephrosis was followed by weekly antegrade or intravenous pyelograms, or both, the splints and drains removed when either maximum resolution occurred or the lesion had become static, the splint coming out a day or so before the pyelostomy tube. Drainage was maintained from twelve days (one case) to sixty-two days (one case), the mean being twenty-nine days plus. The splints and drains were not irrigated regularly and neither sand in the urine nor calcification of tubes appeared. Exclusive of Case 1, the fistulas, following removal of the pyelostomy tube, closed immediately twelve times and only two drained more than twenty-four hours, none over forty-eight. The nephrostomy fistula, however, remained open eight days. No postoperative secondary lower ureteral strictures were encountered. Eight of the twenty-one plastic operations on the ureteropelvic junction were assessed as cured, nine as improved and four as failures.

### CASE REPORTS

CASE 1. A twenty-two year old white man was evacuated to the 141st General Hospital from Korea because of persistent backache of more than a year's duration. Investigation led to the discovery of bilateral extrarenal hydronephrosis due to ureteropelvic obstructions, more marked on the left. At surgery on June 25, 1951, the left pelvis was found trapped between the renal artery posteriorly and the renal vein anteriorly, these forming a vise 1 cm. above the junction; below the ureteropelvic junction was a double elbow kink, and 1.5 cm. lower an intrinsic stricture which would not admit a No. 5 F. ureteral catheter. The pelvis contained 35 cc. of sterile urine. It was believed that nephrectomy would be the procedure of choice were the lesion not bilateral; therefore, the kinks were released and intubated ureterotomy was performed. A No. 10 F. red rubber catheter was used as the splint. Convalescence was uneventful until after the splint was removed on the twenty-second postoperative day, the pyelostomy tube inadvertently falling out a few hours later. The fistula failed to close, poorly controlled bouts of recurring pyelonephritis developed, and the patient's condition worsened steadily.

Reoperation was performed on August 13, 1951. The pyelostomy had healed; the fistula arose from a spontaneous rupture of the now widely dilated inferior calyx. This was closed, the pelvis was divided and sutured posteriorly behind the artery, apparently relieving the pressure, and the ureter splinted with a No. 12 F. red rubber catheter. Convalescence was again uneventful and he was evacuated to the United States on September 1, 1951. A follow-up note stated that the splint was removed six weeks postoperatively; the fistula again failed to close and nephrectomy was performed.

Two alternate procedures, in retrospect, probably would have exhibited greater wisdom: either backing off entirely, or nephrectomy, and I am not at all certain the first would have not been by far the wisest.

CASE 11. A thirty-one year old white housewife (para 1, gravida 1) was admitted to the Urologic Section, United States Army Hospital, Fort Sill, Oklahoma on August 10, 1954, with known extrarenal hydronephrosis due to a ureteropelvic obstruction, impassable to a No. 4 F. catheter, containing a large calculus. At surgery on August 13, 1954, a filiform intrinsic stricture was found; the pelvis contained 80 cc. of urine. The stone was removed and the ureter intubated with a No. 14 F. red rubber catheter. Convalescence was uneventful and the patient was discharged on the fifth postoperative day. The splint was removed on the forty-first postoperative day. Ten days later an attempt was made to dilate the ureter cystoscopically and a No. 5 F. ureteral catheter encountered an impassable obstruction at the ureteropelvic junction. The patient was advised to consult the urologist at her husband's next station promptly (they were leaving the next morning), but reoperation was delayed until January 13, 1955. A recurrent intrinsic stricture was found; the pelvis was resected and a Foley Y-plasty performed. The ureter was intubated with a No. 14 F. polyethylene splint. Her last surgeon stated that she was well in October, 1955.

What caused the recurrence? Similar episodes can be found in the literature [*20,23*].

CASE III. A twenty-seven year old white housewife (para III, gravida IV) was admitted to the Urologic Section, United States Army Hospital, Fort Sill, Oklahoma on October 18, 1954, complaining of recurring pain in the left flank of five years' duration. A urologic investi-

FIG. 2A. Case IV. Preoperative retrograde pyelogram.

FIG. 2B. Case IV. Postoperative ureteropyelogram taken November 9, 1955.

gation disclosed a large extrarenal hydronephrosis due to a uretero-obstruction. At surgery on October 26, 1954, a double elbow kink, aberrant vein and intrinsic stricture which would not admit a No. 8 F. ureteral catheter were found. The pelvic residual was 77 cc. Intubated ureterotomy was performed, the splint a No. 12 F. red rubber catheter. Convalescence was uneventful and the patient was discharged on the twelfth postoperative day; the splint was left in place thirty-seven days. When seen on June 5, 1955, she had been asymptomatic since surgery, no pelvic residual was found, and the ureter took a No. 10 F. catheter readily.

She returned on September 9, 1955, complaining of a sudden recurrence of symptoms eight days earlier. A residual of 38 cc. of turbid urine was found, while the ureteropyelogram was hardly distinguishable from the original study. Ureteral dilatations were performed, but to no avail. She was readmitted on November 29, 1955, for surgery on December 1st. To my surprise, the only obstruction proved to be vein wrapped tightly around the ureteropelvic junction. Since cotton had been used at the first procedure, the original ligature was found; a vein was seen arising from a small nest of adhesions behind the ligature, and this gave rise to the offending branch. The adhesions, however, did not embrace the ureteral lumen, which readily admitted a No. 16 F. polyethylene tube. Seventeen small stones were found in the pelvis (emphasizing the importance of an immediate preoperative plain plate, which had not been taken in this instance). The pelvic residual was 58 cc. Convalescence was uneventful and the patient was discharged on the fifth postoperative day. The polyethylene splint was removed on the twenty-fourth postoperative day when it began to fray dangerously, a hazard previously encountered with this material. She has again been asymptomatic since, and had a residual of 8 cc. of sparkling clear urine on March 6, 1956.

The recurrence of this woman's disease resulted from the growth of a newly sprouted vein. The probabilities of such an accident must be infinitely small.

CASE IV. (Figures 2A and B.) A twenty year old white man, a rodeo rider in civilian life, was admitted to the Urologic Section, United States Army Hospital, Fort Sill, Oklahoma at 7:00 A.M. on July 17, 1955. He had experienced violent left renal colic since about

4:30 that morning. He further added that he had had occasional attacks of left-sided backache for years, which he blamed on his occupation. A giant hydronephrosis was found and a No. 10 F. ureteral catheter was left indwelling on July 25, 1955. On the evening of July 28th, he experienced a bed-shaking chill and his temperature rose to 105°F. Surgery was cancelled. He ran a sustained, septic fever, ranging between 104.2°F. and 106.2°F. until Sunday afternoon, July 31st. Although the ureteral catheter drained copiously, the mass in the left flank seemed to be growing steadily and it was thought he might have a perinephric abscess. Exploratory laparotomy was performed at 2:00 P.M. There was no abscess. The kidney was tense, but a surprisingly good cortex was found. Nephrostomy was performed and 1,500 cc. of foul purulent urine were removed. The patient's temperature dropped from 106°F. to 99.2°F. during the operation.

Convalescence was stormy, complicated by a drug fever (terramycin®) and a toxic psychosis. Nonetheless, he was well enough to go on convalescent leave August 19, 1955, and intubated ureterotomy was performed on September 9th. The obstruction consisted of a nest of adhesions and a small artery. A No. 14 F. polyethylene tube was used as a splint. Convalescence was uneventful and the splint was removed on September 30th. An adequate ureteropelvic junction was demonstrated and the nephrostomy tube was removed on October 1st. The fistula did not close until October 9th. Following a second leave and atypical right-sided pneumonia, he was returned to duty on November 11, 1955. When last examined on January 3, 1956, the ureter admitted a No. 10 F. catheter and the pelvic residual was 12 cc. and grossly uninfected.

Patience and conservative surgery not only salvaged a kidney but also saved a citizen soldier.

*Ureterovesical Obstructions.* Two left-sided ureterovesical obstructions in men of nineteen and twenty-three years of age were seen. Both were associated with massive hydroureters and hydronephroses; the obstructions proved to be intrinsic, intramural strictures. Suprapubic intubated ureterotomies were performed; a No. 14 F. red rubber catheter was used in one, a No. 16 F. red rubber catheter in the other. Convalescence was uneventful, the splints were left indwelling six weeks, and both have been asymptomatic since, one two and a half years, the other three years postoperatively. When last seen, eight months and seven months postoperatively, respectively, neither carried any residual urine, drainage was prompt and there was no infection. Both are considered "cured." One of these cases has been reported elsewhere [8]. The operating time was three hours, fifteen minutes, and three hours, twenty-two minutes, respectively.

*Defects in Innervation (Megaloureter).* Two cases of so-called "megaloureter" were seen, one in a thirty-one year old white man at the left ureterovesical junction, the other in a twenty-four year old white woman at the pelvic brim. The symptoms in both patients consisted of chronic, long-standing backache on the affected side associated with frequent bouts of colic and one or more episodes of pyelonephritis. Neither had evidence of similar lesions in the large bowel or bladder. At surgery, the ureteral peristaltic wave could be seen stopping abruptly at the termination of the dilated segment. The man was treated by means of suprapubic intubated ureterotomy on November 20, 1952, with indifferent success (a questionable "improved"). His convalescence was complicated by one postoperative attack of pyelonephritis.

Twelve centimeters of the woman's ureter were resected on November 4, 1954, the proximal segment replanted in the dome of the bladder by means of a nipple type anastomosis over a No. 18 F. red rubber catheter brought out through the urethra. The splint was left indwelling only six days and convalescence was complicated by two episodes of pyelonephritis. In June, 1955, a stricture of the new orifice developed. By February, 1956, dilation was required once every eight to ten weeks. She was completely asymptomatic, carried no residual and the urine was uninfected. The assessment is "improved."

As far as I can ascertain from previous reports, this was the longest successful resection of the lower ureter with reimplantation in the bladder, in which the distal ureter was not reconstructed by means of a bladder flap.

*Ectopic (Pelvic) Kidneys.* Two right-sided hydronephroses were seen in men, forty and thirty-four years of age, respectively. In each instance the hilus faced cephalad and the ureter looped over the renal vessels, which arose from

the internal iliacs just below the latter's origins. One kidney was not functioning and was filled with stones. Transperitoneal nephrectomies were performed on June 1, 1951 and January 21, 1953, respectively. No complications developed. There have been no further follow-up notes.

*Other Abnormalities.* One ectopic opening of the left ureter in a seminal vesicle with an associated hydroureter and atrophic hydronephrosis has been reported elsewhere [9]. A large hydronephrosis secondary to a horseshoe kidney, complicated by a stag-horn calculus and seventeen smaller stones, was seen in an obese fifty-seven year old white man with hypertension and diabetes. Simple pyelolithotomy was performed on November 18, 1953. Convalescence was uneventful. As of January, 1956, more than two years postoperatively, there has been no recurrence of the stones. The hydronephrosis is, of course, unchanged.

*Causes Unknown.* In four patients (12.5 per cent) no cause for the hydronephrosis could be found. These were: a seven month old Negro infant, with normal kidneys in the left lumbar region and right pelvis, who had a large right lumbar hydronephrosis (nephrectomy performed on April 7, 1955); a massive hydronephrosis (2,000 cc. in kidney) in a thirty-one year old white man (nephrectomy and subtotal ureterectomy performed on April 20, 1953); a calculus pyohydronephrosis previously reported [8]; and a hydronephrosis complicated by a large stone in an eighteen year old white woman, four and one-half months' pregnant. The stone was removed on February 4, 1955, at which time the ureter was carefully explored for possible obstruction. She was subsequently delivered of a full term fetus. There has been no change in the hydronephrosis since delivery. Convalescence in these four patients was without complications.


## SUMMARY

A group of thirty-two persons (twenty-seven men, 5 women) with hydronephroses has been studied. They ranged in age from seven months to fifty-seven years; thirty were Caucasians and two were Negroes. Negroes comprise roughly 10 per cent of the population of the United States and the Armed Services are a cross section of the citizenry of this country, so that the disparity may be significant.

Thirty-seven known surgical procedures were performed: intubated ureterotomies, twenty-two; simple division of obstructing vessels, one; pyelolithotomies, two; transposition of pelvis behind renal artery, one; preliminary nephrostomy, one; nephrectomies, seven (performed by the author). Elsewhere a Foley Y-plasty and a nephrectomy were performed on two of my patients classified as failures.

Twenty-seven of my definitive conservative operations (on twenty-five persons) were evaluated as follows: cured, ten (37 per cent); improved, thirteen (48 per cent); and failed, four (15 per cent). Since two of my failures were in the same man, the corrected rate became three failures in twenty-five persons with hydronephrosis (12 per cent). (A second patient termed a failure was reoperated upon by me thirteen months later and converted to "improved.") There were no deaths, and none of the twenty-six people on active duty were separated from the Service because of a urinary tract disability.


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Pulmonary Carcinoma. Pathogenesis, Diagnosis and Treatment. Edited by Edgar Mayer, M.D. and Herbert C. Maier, M.D., with 18 Contributors. 540 pages, illustrated, some illustrations in color. Philadelphia, 1956. J. B. Lippincott Co. *Price* $15.00. (Timely and authoritative.)

The Neurosurgical Alleviation of Parkinsonism. By Irving S. Cooper, M.D. 104 pages, with over 67 illustrations. Springfield, Ill., 1956. Charles C Thomas. *Price* $8.50. (Presenting two new technics developed by the author and used successfully in this disease.)

Kenny Visits the Hospital. A Story in Pictures. By Julia Ann Bartosh, R.N. Foreword by Dr. J. Shirley Sweeney. 62 pages, every page with illustrations. New York, 1956. Exposition Press. *Price* $2.50. (Intended to take away the horror of hospitalization for children.)

# Chronic Duodenal Ileus

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CHRONIC duodenal ileus is a clinicopathologic entity characterized by intermittent delay in the passage of the duodenal contents through the transverse duodenum, due to compression of the third part at a point where it traverses the spine, by the root of the mesentery of the small intestine which contains the superior mesenteric artery, vein and nerve.

There are many synonyms for this condition, e.g., chronic gastromesenteric ileus, chronic duodenal stasis, chronic arteriomesenteric occlusion, chronic intermittent duodenal ileus, Wilkie's syndrome, stenosis of the duodenum and megaduodenum.

The literature contains a considerable series, the first case being credited to Boerneus in 1752, as cited by Andrews [*1*]. In 1849 Rokitansky suggested on the basis of autopsy findings that compression of the duodenum by the superior mesenteric vessels might be responsible for dilatation and stasis within the duodenum. According to Rowlands [*18*], in 1900 L. A. Petit confirmed the suggestion that compression of the duodenum by the root of the mesentery was the etiologic factor.

Bloodgood [*2,3*] advanced the theory that prolapse of the cecum pulled on the mesentery of the small intestines and that duodenal obstruction resulted when the last portion of the ileum had a short mesentery. He recorded several operations which he had performed, consisting of colopexy and resection of the cecum and ascending colon as a corrective procedure.

In 1908 Codman [*5*] expressed the belief that chronic obstruction of the duodenum by the root of the mesentery was a common cause of epigastric symptoms and perhaps predisposed to the development of peptic ulcer; also that the change in the animal species from the quadruped to the biped position was an important etiologic factor. The association of the disease with peptic ulcer was confirmed by Wilkie [*22*], was found that in 135 cases 25 per cent were associated with ulcer.

Other theories of the pathogenesis of the condition are: (1) Anomalies of intestinal rotation, such as clockwise rotation of the small intestines through an arc of 90 degrees instead of the usual anticlockwise rotation through an arc of 270 degrees, with the result that the transverse colon lies in close contact with the posterior abdominal wall and is separated from the duodenum anteriorly by the base of the mesentery [*8*]; (2) failure of proper development of the mesenteric attachments of the small and large bowels to the posterior abdominal wall, thus permitting a hypermobile ptotic condition in which the weight of the bowel is suspended by the superior mesenteric vessels and their branches instead of being suspended by the leaves of the mesentery, the end result being the compression of the third portion of the duodenum between the aorta and the spine posteriorly and the superior mesenteric vessels anteriorly; this was the condition which was found in the case presented herein; (3) by the drag of the mesentery in visceroptosis and in postural defects; (4) infiltration of the mesentery by malignant disease; (5) pressure of enlarged mesenteric nodes, either from lymphoblastoma or from tuberculosis, such as the fifteen cases of the latter condition reported by Matthews, Delany and Dragstedt which these authors collected from the literature of hyperplastic tuberculosis of the duodenum followed by stenosis [*15*]; and (6) cicatrization following gastrojejunal or jejunal ulceration after gastrojejunostomy.

*Incidence.* The disease is said to occur more frequently in females than in males, approximately 3–4:1. In Andrews' [*1*] series, however, there were twenty-two females to eighteen males. It occurs more often in females with visceroptosis. Many cases, however, occur in strong, well built males with well developed

abdominal musculature, as reported in several cases by Crump [6]. Several of his cases were in athletes, and one in particular was in a football player.

In 1920 C. C. Higgins reported fifty-six cases [15]. In 1927 Kellogg and Kellogg [13] reported 118 cases. In 1938 Wilkie [22] reported the largest series up to that time, 135 cases in all. It is safe to assume that if a high incidence of suspicion is maintained, more cases will be discovered that otherwise are not detected.

*Symptomatology.* The symptomatology may vary considerably. There may be few or no symptoms except periodic attacks of nausea, pain, sour eructation, vomiting of bile, postprandial fullness, bloating or feeling of a load or weight in the abdomen coming on after meals, with or without special food intolerance. Pain is seldom an outstanding complaint but at times may be a major complaint. It is usually localized in the epigastrium where it remains, or may be referred to the right upper quadrant of the abdomen or to the back. It may vary from a burning sensation to a dull ache, or it may closely simulate biliary colic or peptic ulcer.

The attacks usually are most severe in middle life, from the ages thirty-five to forty, but may have existed periodically since the patient's childhood. The discomfort is usually postprandial, occurring one to four hours after eating. At times the pain may simulate that of a duodenal ulcer, with temporary relief after the ingestion of food.

Vomiting is an important symptom in most severe cases. The vomiting may be a painless, spontaneous projectile type or the patient may vomit with relief of symptoms and learn to induce vomiting to get relief. Another type of vomiting is a cyclic type, associated with headache, general malaise simulating a migraine attack in connection with fatigue, exhaustion and anorexia. Sometimes the vomiting may be so severe and persistent as to suggest high intestinal obstruction.

Some cases are associated with allergic manifestations such as urticaria. As the condition progresses, the patient may lose weight and strength and show signs of emaciation and nutritional deficiency. Anxiety or emotional states may develop in many patients, which may totally mislead the unwary examiner.

At times the patient himself learns that by lying in bed soon after eating or by assuming various positions, especially the knee-chest position, he may lighten or even avoid severe attacks.

*Physical Examination.* The physical examination may leave much to be desired, especially in patients with well developed musculature who are evidently not visceroptotic. Visible peristalsis from a dilated duodenum may reveal active peristalsis, but this is seldom seen. Because of concomitant gastric dilatation, atony and ptosis a succussion sound may sometimes be elicited. Localized epigastric tenderness may or may not be helpful. The nutritional deficiency and loss of weight may simulate malignancy.

The clinical diagnosis can be made only by roentgen examination. If possible it is best to study the patient during an attack, for at times the emptying of the duodenum may be temporarily satisfactory and marked dilatation of the duodenum may be missed. The two features necessary for the diagnosis are dilatation of the duodenum and retention of barium beyond the normal time limit.

Gastric analysis is not of much value unless one does the night secretion test as advocated by Dragstedt [7] in ulcer cases, or unless microscopic examination of the duodenal contents is made and other causes of duodenitis such as diverticula are ruled out.

In the differential diagnosis peptic ulcer, which is a concomitant lesion in approximately 25 per cent of cases, must be ruled out, as well as cholecystitis, pancreatitis or duodenitis, malfunctioning stoma after gastroenterostomy and acute dilatation of the stomach occurring postoperatively.

*Treatment.* Medical management in the severe cases is ineffective and should be used only to prepare the patient for definitive surgery. It should be directed toward the relief of vomiting, and the correction of fluid and electrolyte imbalance, of nutritional deficiencies and of the comcomitant anemia and hypoproteinemia by blood transfusions. Gastric lavage and postural drainage in the recumbent or knee-chest position may be employed.

Duodenojejunostomy was first recommended by Bloodgood [2] in 1907, first performed by Stavely [20] in 1908, and performed by Wilkie [22] in 1938.

Most cases respond dramatically to duodenojejunostomy with or without associated gastroenterostomy. The latter by itself is not always

FIG. 1. Preoperative roentogram showing marked gastric and duodenal dilatation, with a constriction at the second portion of the duodenum due to compression of the superior mesenteric vessels.

FIG. 2. Postoperative roentogram showing return of stomach and duodenum to normal, with relief of obstruction to second portion of the duodenum.

successful. Gastric resection is generally regarded as too severe an operation for the malady which can be cured so much easier by duodenojejunostomy.

In Wilkie's series he performed duodenojejunostomy in 127 cases. In eighty-nine of these it was the sole operative procedure; in twelve cases it was associated with gastrojejunostomy, in seventeen cases with gastroduodenostomy, and in six other cases with some operation on the biliary passages.

### CASE REPORT

C. J., a thirty-six year old woman, was admitted to the Provident Hospital on November 22, 1954.

Her chief complaint was epigastric pain, nausea and vomiting. Her family history was non-contributory. She stated that as far back as she could remember she had had this condition. She learned, however, that if she remained quiet she was able to retain some of her food for four to six hours; but when she moved about again, the food regurgitated. She also learned that fried or greasy foods increased her discomfort. The pain varied from a dull ache to a colicky pain localized in the mid-epigastrium, occasionally radiating to the back but not to the shoulder. There was no relief of the discomfort by the intake of food; in fact, sometimes in order to avoid the distress she induced vomiting.

At the age of four she had suffered a severe burn covering the anterior trunk and neck, approximately a 33 per cent burn of the body surface. Her right breast was completely destroyed and the left one was almost destroyed. She was a gravida 11, para 11. With her last child she was told that she had toxemia of pregnancy, with increase of her nausea and vomiting and edema of extremities. She had had rheumatic fever. At no time had she vomited blood by name or symptom, and she had never noticed blood in the stools or any tarry stools. In 1952 she had undergone cholecystectomy and appendectomy elsewhere for a similar syndrome, but with no relief of the

condition; in fact, the condition was aggravated after the operation, the pain, nausea and vomiting increasing in frequency and severity.

At the present admission her temperature, pulse and respiration were normal. Her blood pressure was 110/60. She weighed 117 pounds which represented an 18 pound loss of weight in approximately one year. Despite the history of long-standing vomiting, the skin over her back and extremities had its normal turgor. An essential feature in the physical examination was an eschar extending from her chin down to the pubic area and involving both arms and her neck. There was a right paramedian scar extending from the xiphoid process to approximately 2½ cm. below the umbilicus. Abdominal tenderness was present in the epigastrium, but there was no splinting of the abdomen and no rebound tenderness. Auscultation of the abdomen showed normal bowel sounds.

The blood count showed a hematocrit of 34 per cent, icterus index 7.6 units, non-protein nitrogen 27.0, alkaline phosphatase 2.2 Bodansky units, total protein 8 gm. per cent, albumin 4.1 gm. per cent, globulin 3.9 gm. per cent, and albumin-globulin ratio 1.05:1. The direct van den Bergh test was negative, indirect van den Bergh test 0.50. The urine showed a specific gravity of 1.015 and no albumin, sugar or casts. The red blood cell count was 3,310,000; the Schilling differential was normal. An upper gastrointestinal series showed a markedly dilated duodenum in its second portion with reversed peristalsis and with marked delay in emptying the stomach, with six-hour residue. (Fig. 1.)

On November 24th the patient was taken to the operating room with a diagnosis of chronic duodenal stasis, and an exploratory laparotomy was performed under spinal anesthesia. The abdomen was opened with a curved, bilateral subcostal incision. The gallbladder and appendix were missing. The stomach was tremendously dilated and its musculature thickened. The duodenum was also greatly dilated, measuring approximately 12 by 10 by 10 cm. There was marked visible peristalsis. No scar was found in the pylorus or duodenum. The intestines were found for the most part in the pelvis. No other pathologic condition was found in the abdomen. The lesser omental bursa was opened and the ligament of Treitz was found. It was freed and a retrocolic isoperistaltic duodenojejunostomy was performed without clamps.

The interior of the duodenum was explored before making an anastomosis manually. No ulcerations were found. It was found impossible to pass the finger into the third portion of the duodenum unless the intestines were lifted up and maintained out of the pelvis. The lesser sac was then closed and the abdomen closed in routine fashion without drainage.

The patient vomited several times for three days following the operation and then the vomiting ceased. On the fourth day she was fed, after intragastric suction had been employed for three days. The patient left the hospital on the twelfth postoperative day at which time she was retaining all her food. (Fig. 2.)

The patient has been followed up since the operation. She has had no further attacks of vomiting, no more attacks of pain or epigastric distress and has gained 20 pounds in weight.

## SUMMARY AND CONCLUSIONS

1. A case of chronic duodenal ileus has been presented.

2. The pathogenesis of the disorder has been discussed, together with the symptomatology of the disease.

3. The technic of gastrojejunostomy is indicated as likely to produce the most beneficial results when performed retrocolic, isoperistaltic and without clamps.

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A VARIETY of causes may produce postcholecystectomy dyskinesia. When it is due to inflammation in the head of the pancreas, choledochoduodenostomy or choledochoenterostomy (internal drainage) may be indicated and should give relief; some cases would be benefited by drainage of the common bile duct through a T-tube. This would be termed "external drainage" and relieves the increased pressure in the bile ducts. The operation is simpler but much biliary fluid may be lost. Cases due to sphincteritis require sphincterotomy for relief. Dysfunction of the sphincter of Oddi is a frequent cause of this syndrome. Thus it is obvious that an exploratory operation is first indicated to try to learn the cause of the postcholecystectomy syndrome. When no specific cause, as mentioned previously, can be found, relief may still be obtained if the splanchnic nerves are blocked (by alcohol injection) or resected. (*Richard A. Leonardo, M.D.*)

# The Clinical Incidence of Congenital Uterine Anomalies

## WITH A REPORT OF FIFTEEN CASES

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Publications in the recent literature indicate that the existence of congenital uterine anomalies is more frequent than previously suspected. This impression is based on the increased number of solitary case reports which have appeared in the last two decades. However, to date few series of cases have been reported which permit an evaluation as to the incidence of these anomalies. The purpose of this paper is to report a series of fifteen cases of congenital uterine anomalies encountered during the eight-year period from 1949 to 1956 on the obstetric and gynecologic service of a small general hospital.

Although uterine anomalies were recognized in the middle ages, and in 1669 Mauriceau described one case of uterus bicornis unicollis with pregnancy in a rudimentary horn, it was not until 1838 that the first series of cases was analyzed and reported by von Rokitansky [22], followed by a similar report by Foerster [9] in 1859. He divided the various types and combinations into three major groups according to the presumed time of onset of the developmental defects. These three groups were subdivided by Fuerst [10] in 1867 and extended by von Winkel [28] in 1899. In 1912 Kermauner [13] introduced his classic scheme again based on three groups which, in its final version, appeared in Halban and Seitz's "Biology and Pathology of the Female" as well as in Kaufmann's "Pathological Anatomy" and often is referred to as "Kaufmann's classification."

### CLASSIFICATION OF GENITAL ANOMALIES (KERMAUNER SCHEME)

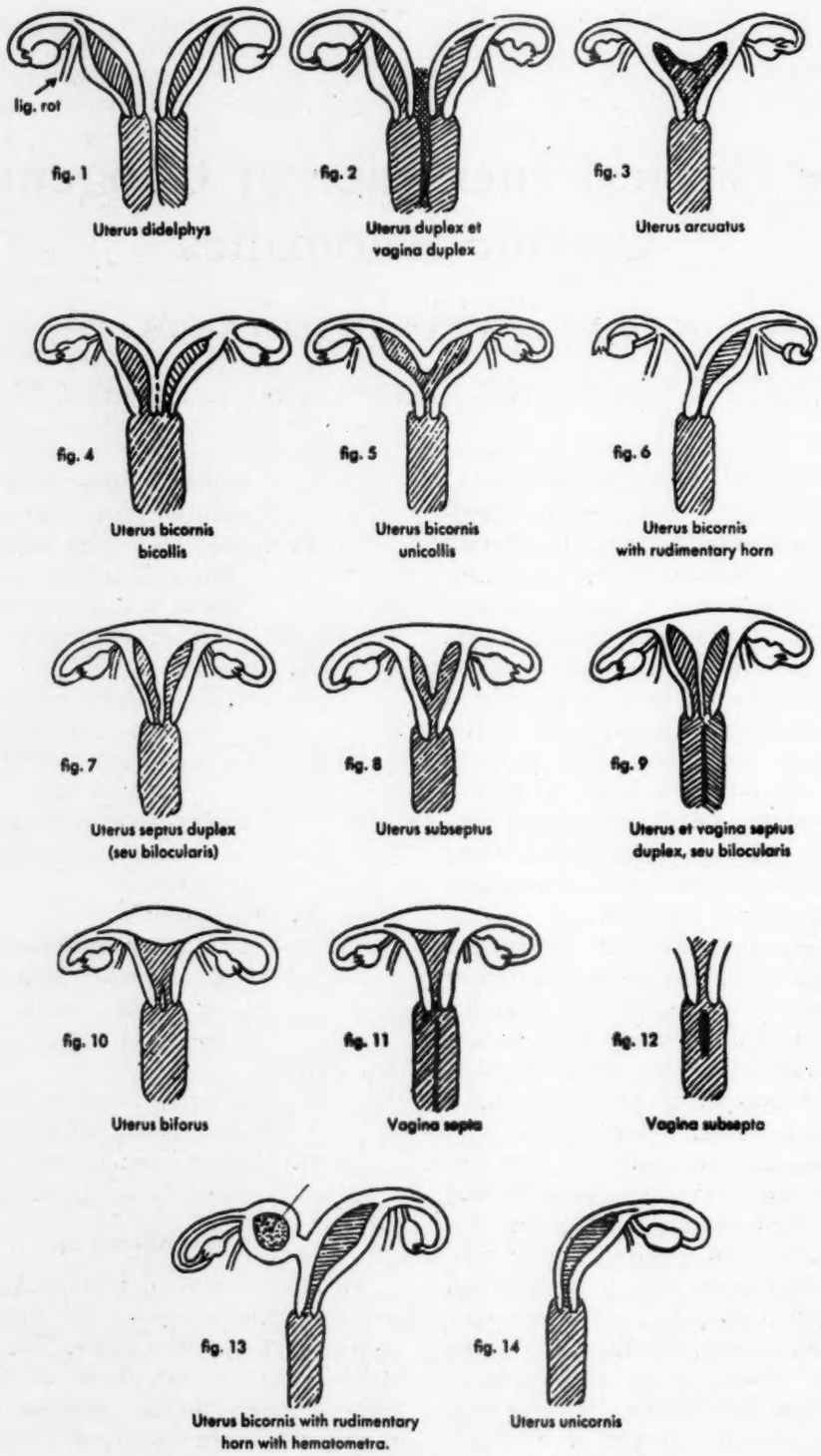
I. Simple duplication
   - A. Incomplete joining of müllerian ducts which results in symmetric false reduplication: uterus didelphys
   - B. Complete joining of müllerian ducts with persistence of the partition: uterus septus duplex

II. Rudimentary development
   - A. Aplasia
     1. Incomplete development of both sides (symmetric): absence of tubes, uterus or vagina or parts of them
     2. Incomplete development of one side (asymmetric): uterus unicornis
   - B. Hypoplasia
     Symmetric or asymmetric development with hypoplasia of one or more parts, unilateral or bilateral

III. Atresia
   - A. Symmetric: atresia of cervix, vagina or fundus uteri (uterus solidus)
   - B. Asymmetric: uterus bicornis with rudimentary horn

### EMBRYOLOGY

The two müllerian (paramesonephric) ducts are the predecessors of the tubes, uterus and upper part of the vagina. They first appear during the seventh week of embryonic life and lie close to the wolffian (mesonephric) ducts, which are already developed. Beginning at the caudal end both müllerian ducts start to fuse, the medial septum formed by the joining of both ducts absorbs and a single vagina and uterus (uterus simplex) is formed. There is no fusion of the most cephalad portion of the müllerian ducts, which results in two separate fallopian tubes. Lack of fusion or




FIGS. 1–14. Types of uterine anomalies.

faulty juxtaposition of the müllerian ducts at different levels, as well as faulty absorption of the septum, determines the various types of uterovaginal anomalies. (Figs. 1–14.) In the first event the uterus has a concave fundus, in the latter the fundus appears normal externally, i.e., convex.

In organs which develop normally and in malformations, the development of one part frequently depends on that of a neighboring

part. From this fact it follows that deviation from the normal pattern may result in changes far beyond the boundaries of the primary site of damage. In the human embryo, the development of the tubes, uterus and upper part of the vagina depends on normal bilateral müllerian ducts. However, development of these genital organs and the permanent kidney also depends on the presence of a normal wolffian duct. Slight damage at any time to the growing wolffian duct will result in failure of development of the entire duct from that point onward, i.e., aplasia of the homolateral kidney, and also in the absence of all or part of the organs formed by the müllerian ducts. This basic knowledge of experimental embryology explains the frequent coexistence of anomalies of both the müllerian and wolffian organs (urogenital tract). It also indicates that the damage causing the anomalous development originated prior to the separation of both ducts into independent systems and the formation of their respective organs. Damage to the wolffian duct after the point of separation from the müllerian duct does not cause genital malformations, and conversely faulty development of one of the müllerian ducts does not affect the further normal development of the kidney.

### INCIDENCE

It is extremely difficult to give accurate figures concerning the occurrence of uterine anomalies in general and of their respective types in particular. Little information of value has been obtained from large series of autopsy material, and the majority of cases reported have been published as solitary case reports, which do not permit statistical evaluation. Only three analyses of compilations from the literature exist and the true incidence of these anomalies is unknown. Beaver and Abbott [2] collected 246 cases from the literature during the period from 1922 to 1936, of which forty were complicated by ruptured ectopic pregnancy. Strassmann [26] reviewed 128 published cases in which operative plastic unification of a double uterus had been performed. Taylor [27] and Eisaman [4] estimated that lack of fusion of the müllerian ducts, either complete or incomplete, occurs once in every 1,500 obstetric patients and once in every 2,000 gynecologic patients. On the other hand, Moore [19] reports from private records that one in every 500 to 600 women present some type of congenital anomaly of the genital tract. We have found only four publications reporting direct figures, obtained from hospital records, regarding the incidence of these anomalies. Falls [6] reported 155 cases of uterus arcuatus in 7,553 deliveries (2 per cent). Kimura [15] gives the incidence of uterus bicornis during a five-year period as 0.14 per cent (fifty-two cases in a series of 36,785 outpatients). Smith [24] found thirty-five cases of uterine anomalies during a thirty-year period at the New York Lying-In Hospital in a total of 142,000 patients, i.e., one in every 4,057 patients. He stated, however, that during a five-year period of personal observation he saw nineteen cases in a total of 27,800 patients, i.e., one in every 1,458 cases or an incidence of 0.06 per cent. Fenton and Singh [7] found one instance of uterine anomalies in every 633 deliveries or 0.15 per cent. Two other hospital series are reported in which no incidence is given; In [21] Phillip's series fifty cases were recorded, and in Pfleiderer's [20] series ninety-three cases of uterine anomalies were seen during a twenty-year period at the Tuebingen Frauenklinik. The latter were subdivided as follows: uterus bicornis bicollis, 15; uterus bicornis unicollis, 15; uterus bicornis with rudimentary horn, 6; uterus septus duplex, 16; uterus arcuatus, 27; and uterus solidus with vaginal atresia, 14.

In the series under consideration, fifteen cases of proved uterine anomalies were encountered during the eight-year period from 1949 to 1956. During this period 7,500 women were admitted to the Department of Obstetrics and Gynecology, 3,650 for normal vaginal deliveries and 3,850 for gynecologic procedures (pelvic examination under anesthesia, Rubin's test, dilatation and curettage, laparotomy, cesarean section, and the like), giving a clinical incidence of one in every 500 patients or 0.2 per cent. This figure is in agreement with Moore's impression, and Kimura's and Fenton and Singh's findings, in material seven times larger. The figure tends to indicate that the incidence of uterine anomalies is still considerably higher than the estimates of Taylor and Eisaman. Our fifteen cases are subdivided as follows: uterus bicornis bicollis, five (four with vaginal septa); uterus bicornis unicollis, three; uterus septus duplex, two (one with vaginal septum); uterus subseptus, three;

uterus didelphys, one; and uterus solidus, one.

TYPES OF UTERINE ANOMALIES

To eliminate confusion and for clinical purposes, a standard nomenclature of uterine anomalies is essential. It must be descriptive in nature and related to the final gross appearance of the anomaly, rather than based upon embryologic considerations. This nomenclature appears in Veit-Stoeckel's textbook, fully illustrated. The more frequent anomalies are shown in Figures 1–14. Taylor in 1943 and Jarcho in 1946 suggested simplified descriptive classifications by arbitrarily limiting the types to five or seven major forms, respectively, and disregarding the less common anomalies: *Taylor's Classification:* (1) uterus arcuatus, (2) double uterus with a single cervix, (3) septate uterus with single or septate vagina, (4) double uterus with double cervix and (5) uterus with rudimentary horn or unicornis. *Jarcho's Classification:* (1) uterus didelphys, (2) uterus bicornis bicollis, (3) uterus bicornis unicollis, (4) uterus septus, (5) uterus subseptus, (6) uterus arcuatus and (7) uterus unicornis.

*Lack of Fusion or Faulty Juxtaposition of Müllerian Ducts (Fundus Concave)*

*Uterus Didelphys.* (Fig. 1.) This is a very rare condition in which there is complete false duplication of the cervix and uterus due to complete lack of fusion of müllerian ducts (in contradistinction to true duplication, in which each uterus has two tubes), both organs lying separately side by side and each having only one tube and ovary. The vagina usually has a full length septum, but an incomplete septum or a single vagina may be present. Phylogenetically, this form occurs in the didelphyans, opossum and kangaroo.

*Uterus Duplex et Vagina Duplex.* (Fig. 2.) This represents a transitional stage between uterus didelphys and uterus bicornis bicollis. It can be diagnosed only after removal of the specimen or at autopsy. For practical purposes, this classification should be disregarded.

*Uterus Arcuatus or Uterus Cordiformis.* (Fig. 3.) This is the most common and least significant of all uterine anomalies. The only evidence of malformation is an external indentation of the fundus. There is a single vagina, a single cervix and one uterine cavity. During pregnancy the fundus develops marked irregularities of contour, resulting in prematurity, malpresentation and retained placenta.

*Uterus Bicornis Bicollis or Bicornis Duplex.* (Fig. 4.) This is a rather common anomaly. There are two separate uterine horns fused at the lower uterine segment, and the cervices, although fused, present with two separate ostiums. The vagina may be single or divided by a complete or incomplete septum. Each uterine horn has only one tube and ovary. This condition is frequently associated with aplasia of the kidney or other anomalies. A rectovesical ligament is often encountered here. Phylogenetically, this form occurs in the rodents, rabbit and squirrel. It should be emphasized that a purely clinical differentiation between uterus bicornis bicollis and uterus didelphys is not possible. Both may have single or divided vaginas and, furthermore, septums may become obliterated by parturition and coitus. Only complete removal of the specimen affords correct classification, and in the literature many cases of uterus bicornis bicollis with septate vagina are being reported as uterus didelphys.

*Uterus Bicornis Unicollis or Bicornuate Uterus.* (Fig. 5.) There is a single vagina and cervix but the body of the uterus is bifid with an external depression. There is lack of fusion of the cephalad portion of the müllerian ducts which results in two partially separated horns. This anomaly is usually referred to as "bicornuate uterus" and is found in the carnivores, cat and dog.

*Uterus Bicornis with Rudimentary Horn.* (Fig. 6.) This form is frequently encountered and represents partial asymmetric atresia. The rudimentary horn may appear as a round and solid mass or hollow cavity. The stalk communicating with the fully developed horn may be either hollow (direct communication) or solid. Ectopic pregnancy in the rudimentary horn by external migration of the spermatozoa is an unusual event, although it occurs frequently, in cases of solid communicating stalk.

*Faulty Absorption of Septums (Fundus Convex)*

*Uterus Septus Duplex or Septus Bilocularis.* (Fig. 7.) Externally the uterus appears normal, internally there is a longitudinal septum, dividing corpus, cavum and cervix into two equal halves. The dividing septum may extend further caudad which results in a complete

vaginal septum, i.e., uterus et vagina septus duplex or bilocularis. (Fig. 9.) Speculum examination shows two separate cervical openings but bimanual palpation reveals a normal uterus. Renal aplasia may be associated with this form.

*Uterus Subseptus.* (Fig. 8.) There is a single cervix and single uterine cavity, partially divided by a wedge-shaped fundic septum. This form is found in the horse and ass.

*Uterus et Vagina Septus Duplex or Septate Uterus with Septate Vagina.* (Fig. 9.) See discussion on uterus septus duplex.

*Uterus Biforis.* (Fig. 10.) There is a normal fundus and uterine cavity but the cervix is divided by a small intracervical septum. This form is found in the monotremes, anteater.

*Uterus Simplex with Complete or Incomplete Vaginal Septum.* This is a normal uterus with two tubes; however, by faulty absorption of the caudal portion of the medial septum, a complete (Fig. 11) or incomplete (Fig. 12) vaginal septum persists as the only sign of anomalous development.

*Uterus Bicornis with Rudimentary Horn with Hematometra.* (Fig. 13.) This is a complication of uterus bicornis with rudimentary horn. Hematometra results from the presence of a solid communicating stalk, preventing drainage of menstrual discharge into the normally developed horn. Retrograde menstruation and at times pelvic endometriosis may result in cases of patency of the tube and rudimentary horn.

*Uterus Unicornis.* (Fig. 14.) This is a very rare condition, resulting from complete unilateral aplasia of one müllerian duct. There is one uterine cavity, which may appear deviated from the normal axis, one cervix and only one fallopian tube.

## ETIOLOGY AND DIAGNOSIS

Numerous theories have been advanced to explain the etiology of uterine malformations, but no single one has been accepted as satisfactory to date. These have been reviewed by Granberry and Faust [*11*] and include such factors as defective germ plasm, hormonal imbalance, unfavorable environment, slower development of the right müllerian duct than of the left, abnormal fusion or incomplete joining of the müllerian ducts, rudimentary development of one or both ducts.

Since even a minor form of uterine malformation in the pregnant patient may cause serious complications, such as habitual abortions, premature deliveries, malpresentation, uterine rupture and faulty involution with postpartum hemorrhage, correct and early recognition of this condition is of paramount importance. However, many cases are first discovered during delivery, laparotomy or at autopsy. Proper speculum visualization and bimanual pelvic examination usually will reveal any duplicity of cervix or fundus, as well as the presence of vaginal septums. Probing, diagnostic dilatation and curettage, and hysterosalpingography will further establish the presence of internal deviations such as uterus arcuatus, uterus biforis and uterus subseptus, which cannot be demonstrated by routine examination procedures. Excretory urograms always should be taken as soon as practical after the diagnosis has been established, to determine the presence of such associated anomalies as absence of the kidney, duplication or horseshoe kidney. The clinical history is usually a limited diagnostic aid because of lack of specific symptomatology. The importance of routine pelvic examination is clearly demonstrated by the fact that eleven of our fifteen cases were diagnosed before complications arose.

## CLINICAL SIGNIFICANCE

Uterine malformations are clinically significant mainly because of the occurrence of associated anomalies, a higher abortion rate, increased fetal mortality, superfetation, postmaturity, malpresentation of the fetus at delivery and other complications during parturition. Associated anomalies are by no means limited to the urogenital system (absence or duplication of kidney and ureter, exstrophy of the bladder, vaginal atresia), but include such defects as imperforate anus, cloaca, duplication of rectum, rachischisis, pseudohermaphroditism and Meckel's diverticulum. Some of these combinations preclude normal reproduction; others are incompatible with life. Most gynecologists agree that there is a marked increase in the rate of abortions associated with uterine anomalies. (Fenton [*7*], 26 per cent; Taylor [*27*], 25 per cent, Findley [*8*], 40 per cent; Miller [*18*], 48 per

cent, Schauffler [23], 53 per cent. An inexperienced observer may be misled by the fact that the non-pregnant horn may continue to menstruate during pregnancy, simulating threatened abortion. However, Taylor believes that bleeding during pregnancy in one horn is due to the passage of a decidual cast from the non-pregnant horn. Smith and also Fenton were able to prove statistically that the perinatal mortality rate and the incidence of congenital anomalies of the newborn are considerably higher in women having uterine malformations. An interesting feature is the differentiation between twin pregnancy and superfetation when occurring in association with uterine duplicity, since it has been established that the ratio of "twins" in this condition is 1:12 as compared to 1:89 in uterus simplex (Berkeley [3]). The occurrence of sterility is obvious in cases of gynatresia, uterus solidus and tubal aplasia. Postmaturity up to several weeks is a frequent complication (Falls [5]) and is attributed to weak uterine contractions caused by poorly developed and deranged muscle layers. Uterine atony with postpartum hemorrhage and uterine rupture during labor are also potential dangers in most types of uterine malformations for the same reasons. Complete and incomplete septums as in uterus septus, subseptus and arcuatus, predispose to transverse presentation, frequently requiring cesarean section. Falls states that in his series of 134 cases, breech presentation occurred in 11 per cent, an incidence three times the accepted normal figure. In uterus bicornis the non-pregnant, enlarged horn may obstruct the birth canal and interfere with normal delivery, even in cases of vertex presentation, as we encountered in this series. Recently, the impression that uterine malformations are no absolute indication for cesarean section has found more and more supporters. In Miller's [18] series of uterus didelphys 42 per cent of the patients had spontaneous normal deliveries. Findley [8] reported that in 135 collected cases of uterus didelphys eighty-three of the patients delivered normally; in Falls' [6] series of uterus arcuatus this figure was 86.5 per cent.

### TECHNICS FOR CORRECTION OF UTERINE ANOMALIES

As has been pointed out, in many cases of uterine malformations no symptoms are present, the patients deliver normally and no therapeutic measures are required. However, mention of the conservative corrective procedures at the surgeon's disposal seems warranted, i.e., removal of vaginal and intrauterine septums and plastic reconstruction or unification of the double uterus. Whereas the first procedure is self-explanatory and widely advocated, plastic unification is still a controversial subject and the results are not altogether convincing. Of the 128 collected cases of plastic uterine reconstruction reported by Strassman [26], seventy-one were followed by full term deliveries, ten of which were by cesarean section; the rate of abortions was still very high (59 per cent). Elective salpingectomy, as a preventive measure against future pregnancies, should be considered only as a last resort after repeated unsuccessful trials to carry the fetus to term or after repeated cesarean sections.

### CASE REPORTS

CASE I. V. S., a twenty-three year old woman, gravida 2, para 2, was admitted with a history of abdominal pain, dysmenorrhea and menorrhagia of long-standing. Menarche with marked dysmenorrhea had occurred when she was thirteen years of age. Her periods had always been irregular and lasted from one to two weeks. Cholecystectomy had been performed when she was twenty years of age. Cholesteatosis had been present. She had had two normal deliveries, without detection of anomaly. The family history was non-contributory.

Physical examination was normal except for bilateral cervical ribs with positive Adson's test. Pelvic examination revealed a normal vagina and cervix, bicornuate uterus and left ovarian cyst. Laboratory findings were normal and an intravenous pyelogram revealed no abnormalities.

Dilatation and curettage, and exploratory laparotomy with bisection of tubes were performed. At operation uterus bicornis unicollis, both horns equal in size and left ovarian cyst were noted; the tubes and ovaries were in normal anatomic position and a rectovesical ligament was present. Diagnosis: uterus bicornis unicollis and bilateral cervical ribs.

CASE II. R. S., a twenty-six year old married woman, gravida 6, para 2, was ad-

mitted to the hospital with vaginal bleeding; she was pregnant three and a half months. Menarche was at the age of thirteen. Her periods occurred every twenty-eight days and lasted four days, with slight dysmenorrhea. She had had three miscarriages and two normal deliveries, without detection of any anomaly. The family history was non-contributory.

Physical examination was normal. Pelvic examination revealed a vaginal septum 3 inches long, and twin cervices. The right cervix was dilated and there was bleeding from the external os. The left cervical ostium was closed. The uterus was bicornuate with a three and a half month fetus in the right horn. Laboratory findings were normal. The patient was Rh positive.

Dilatation and curettage of the right uterine horn was performed. Pathologic report: fetus three and a half months. Diagnosis: uterus bicornis bicollis with septate vagina and three and a half month incomplete abortion in the right horn. The patient did not return for follow-up studies and urographic examination.

Case III. R. C., a nineteen year old married woman, gravida 3, para 2, miscarriage 1, was admitted for elective cesarean section for full term pregnancy. Menarche was at the age of thirteen. Her periods were regular, every thirty-two days, and lasted two days. The past history was as follows: After onset of the menses, which were very scant, severe dysmenorrhea developed. At thirteen the patient underwent laparotomy because of atresia of the upper third of the vagina resulting in hematometra. At operation a uterus bicornis bicollis was found, with right hematometra and right hematosalpinx, the right horn containing 650 cc. of old blood which was drained through the vagina. The right hematosalpinx was removed and the patient made an uneventful recovery. At the age of seventeen she married and became pregnant in the left horn; at four and a half months she began to have bleeding from the right horn and passed a decidual cast, which was confirmed by pathologic examination. The pregnancy proceeded normally to term and the patient had active labor pains. However, the fetal head remained floating over the pelvic brim and there was no cervical dilatation. A cesarean section was performed and she was delivered of a normal baby. At the time of operation the non-pregnant uterus was found to be hypertrophied to approximately three times the normal size, obstructing the birth canal and preventing normal engagement. She made an uneventful recovery. Seven months later she had a spontaneous complete abortion, passing a three-month fetus. Dilatation and curettage was performed in both uteri. The pathologic report on the non-pregnant right uterus stated: "Endometrium, showing a hyperplasia like that associated with pregnancy and with a large amount of decidual tissue. No chorionic villi can be seen." Four months later the patient became pregnant again, in the left horn, and proceeded normally to term except for one episode of bleeding from the non-pregnant horn during the fifth month of gestation.

At examination on the present admission laboratory findings were normal. The patient was Rh positive. Physical examination revealed no abnormalities; no intravenous pyelogram was obtained. The family history was non-contributory.

Elective cesarean section was performed and the patient was delivered of a normal baby; bilateral salpingectomy was performed. The non-pregnant uterus was enlarged to two and a half times the normal size. Diagnosis: uterus bicornis bicollis with vagina subsepta and secondary atresia of the upper third of the vagina, resulting in right hematometra and hematosalpinx. A decidual cast was passed from the non-pregnant horn. There was obstruction of the birth canal by the non-pregnant horn, necessitating cesarean section.

Case IV. E. B. was a thirty-eight year old married woman, gravida 0, para 0 (used no precautions). Her periods were regular, every twenty-eight days, lasting five days. Menarche was at the age of fourteen. Her present complaint was severe dysmenorrhea; she had had uterine suspension. The family history was non-contributory.

Physical examination revealed no abnormalities. On pelvic examination there were two separate cervices with a small vaginal septum in between. The uterus was of the infantile type and was normal in contour. Laboratory findings were normal; non-protein nitrogen was 36 mg. per cent. Intravenous pyelogram showed absence of the right kidney; the left kidney was enlarged. Cystoscopic examination

FIG. 15. Case IV. Uterus septus duplex. The opened surgical specimen reveals two completely separate uterine cavities. A toothpick is inserted into each cervical ostium.

FIG. 16. Case VI. Cesarean section in right horn of uterus bicornis bicollis. The left horn appears to be enlarged to twice normal size. Left ovary: cystoma simplex.

revealed the right ureteral orifice to be present, but a catheter could be passed for a distance of only 2 inches. A transitional cell papilloma was removed from the trigone.

Operation (Fig. 15) consisted of total abdominal hysterectomy with preservation of the ovaries. The right kidney was not palpable. The pathologic report was uterus septus duplex with endometriosis interna in the septum and left tubal corner. Diagnosis: uterus septus duplex with incomplete vaginal septum; endometriosis interna in intrauterine septum and left tubal corner; absence of right kidney.

CASE V. M. B., a thirty-seven year old married woman, gravida 3, para 0, miscarriage 3, was admitted because of vaginal bleeding; she was pregnant five months. Menarche was at the age of fifteen. Her periods were regular, every twenty-eight days, and lasted from four to five days. There was no dysmenorrhea or menorrhagia. The patient had had two immature deliveries, at five and a half and six and a half months. When three and a half months pregnant she passed a decidual cast from the non-pregnant horn. She had no cramps or further bleeding and the Xenopus pregnancy test remained positive. The family history was non-contributory.

Laboratory findings were normal. The patient was Rh positive. Her basal metabolic rate was +10; cholesterol was 180 mg. per cent. On physical examination the vagina was normal and there was a single cervix 4 cm. dilated; the membranes had ruptured and a small fetus was presenting (breech) in the right horn of a bicornuate uterus.

An immature fetus in breech presentation was delivered; no urographic studies were done. The patient did not return for follow-up. Diagnosis: uterus bicornis unicollis causing three immature deliveries.

CASE VI. B. P., a twenty-three year old married woman, gravida 1, para 0, miscarriage 0; was admitted because of vaginal bleeding; she was pregnant two months. Menarche was at the age of fourteen. Her periods were regular, every twenty-eight days, and lasted five days. There was no dysmenorrhea or menorrhagia. The past history was non-contributory. There was a family history of myasthenia gravis.

Laboratory findings were normal. The patient was Rh positive. Physical examination revealed no abnormalities. On pelvic examination the vagina was normal. There were two separate cervices, with bleeding from the right external os. The left ostium was closed. The uterus was bicornuate and there was thought to be a two and a half month fetus in the right horn.

Treatment consisted of bed rest and progesterone. The patient went to term without further difficulties. A living baby was delivered by cesarean section through the right horn. (Fig. 16.) The left horn appeared to be enlarged to twice its normal size. Both tubes and ovaries were in normal anatomic position. The left ovary contained a cyst 6 cm. in diameter which was removed and appeared to be a cystoma simplex (pathologic diagnosis). No intravenous

pyelogram was taken. Diagnosis: full term pregnancy in right horn of uterus bicornis bicollis; cystoma simplex, ovary.

Case vii. M. L. was a thirty-two year old married woman, gravida 0, para 0 (used precautions). Menarche was at the age of twelve, with moderate dysmenorrhea. Her periods were regular, every thirty-three days, and lasted five days. Her present complaint was urinary infection; she had had hyperchlorhydria and Milroy's disease. The family history was non-contributory.

On laboratory examination the non-protein nitrogen was 45 mg. per cent and phenolsulfonphthalein test 65 per cent. Physical examination showed no abnormalities except for one-sided ankle edema. On pelvic examination double cervices were present with a short vaginal septum; both ostia were markedly stenotic. The uterus was bicornuate and hysterometry showed both cava to be small and only 3½ cm. deep. Hysterograms revealed two completely separate, small uterine cavities of equal size. The right tube filled normally. In the left tube no filling took place, which could have been due to either aplasia or occlusion. Diagnostic dilatation and curettage showed glandular hyperplasia in one cavum. Intravenous pyelogram showed what was thought to be a 2 by 3 cm. stone in the left kidney and there was no function at all on the left side. The right kidney appeared to be normal.

Since the patient continued to have urinary infection, it was decided to perform a nephrolithotomy. After exploration no left kidney could be found. The left ureter was hypoplastic and could be traced upward into a small, 2 by 3 cm., partially calcified mass, which was excised. The pathologic diagnosis was rudimentary, primitive kidney (mesonephros) with absence of metanephric anlage. Diagnosis: uterus bicornis bicollis with incomplete vaginal septum; rudimentary left kidney.

Case viii. L. S., a twenty-three year old married woman, gravida 0, para 0 (used precautions), was admitted because of acute abdominal pain simulating appendicitis. Menarche was at the age of fourteen, with severe dysmenorrhea. Her periods were regular, every thirty-five days. She had had hematometra at the age of fifteen which was treated with dilatation of the cervix. The family history was non-contributory.

Fig. 17. Case viii. Intravenous pyelogram shows absence of right kidney.

Physical examination revealed no abnormalities other than abdominal rigidity. On pelvic examination the vagina was normal. There were two separate cervices. The uterus was bicornuate.

Exploratory laparotomy was performed, with appendectomy. The right horn of the uterus appeared somewhat smaller than the left horn. Both tubes and ovaries were in normal anatomic position. The left kidney felt enlarged. No right kidney could be palpated and the appendix appeared normal. In the postoperative period the patient had a positive reaction to the urine porphyrin test, which might explain her abdominal symptoms. Subsequent intravenous pyelogram proved the right kidney to be absent. Diagnosis: uterus bicornis bicollis; absence of right kidney; porphyrinuria. (Fig. 17.)

Case ix. W. C., a twenty year old married woman, gravida 0, para 0 (used no precautions), was admitted with the complaint of sterility for four years. Menarche was at the age of thirteen, with no dysmenorrhea. Her periods were regular, every twenty-eight

FIG. 18. Case IX. Uterus subseptus. Hysterogram shows an incomplete septum. Both tubes appear to be occluded. At operation the external uterine contour was found to be normal.

days. The past and family histories were non-contributory.

Physical examination revealed no abnormalities. Findings on pelvic examination were normal except for cervical stenosis and retroversion. Laboratory findings were normal. A previous dilatation and curettage and Rubin's test had shown the tubes to be occluded. Hysterograms showed a uterus subseptus with occlusion of the tubes. (Fig. 18.)

Exploratory laparotomy and salpingoplasty were performed, with excision of the occluded segments and suspension. The uterus appeared normal externally. The tubes were occluded in their distal third. There was no salpingitis isthmica nodosa. Both tubes and ovaries were in normal anatomic position. Both kidneys were palpable. The pathologic diagnosis was obliteration of lumen of fallopian tubes associated with supernumerary channels (malformation ?). Diagnosis: uterus subseptus.

CASE X. G. L., a twenty-four year old married woman, gravida 1, para 1, had had increasing dysmenorrhea for three years. Menarche was at the age of thirteen. Her periods were regular, every twenty-six days. Past history revealed chronic hematuria. The family history was non-contributory.

Physical examination revealed no abnormalities. However, on pelvic examination a left ovarian cyst and normal cervix were found. The patient had hematuria. Retrograde pyelograms showed normal kidneys and an aberrant vessel kinking the left ureter at its upper third.

Dilatation and curettage, and laparotomy with partial resection of the left ovary were performed. The uterus appeared normal externally. A wedge-shaped septum divided the cavum and extended downward almost to the internal ostium. The pathologic diagnosis was secretory endometrium; hemorrhagic cyst of the ovary. Diagnosis: uterus subseptus.

CASE XI. L. R., a twenty-five year old married woman, gravida 0, para 0 (used no precautions), complained of menometrorrhagia and sterility for three years. Menarche was at the age of thirteen. She had had no dysmenorrhea but her periods were irregular. The past history was not significant.

Physical examination revealed no abnormalities. On pelvic examination the vagina, fundus and cervix were normal. Hysterosalpingograms showed a uterus subseptus with complete occlusion of the left tube and partial occlusion of the right tube.

Surgery consisted of dilatation and curettage, exploratory laparotomy and left salpingectomy. The uterine contour was normal. On laboratory study secondary anemia was found. The basal metabolic rate was −6. Intravenous pyelogram showed no abnormalities. Both tubes and ovaries were in normal anatomic position. The left tube was occluded in its mid-portion by a cystic formation. The pathologic diagnosis was hypoestrogenic endometrium, proliferative phase; obliteration of the lumen of the fallopian tube by non-specific granuloma. Diagnosis: uterus subseptus.

CASE XII. R. W., a thirty-eight year old married woman, gravida 0, para 0 (used contraceptives), complained of abdominal pain and backache. She had no dysmenorrhea and her periods were regular, every twenty-eight days. The past history was non-contributory.

Physical examination was normal. On pelvic examination a single cervix was found. The fundus of the uterus felt irregular and there were bilateral, cystic adnexal masses which were palpable.

Total hysterectomy and bilateral salpingo-oophorectomy were performed. The uterus was bicornuate. Both tubes and ovaries were trans-

formed into cystic masses 3 inches in diameter and filled with clear fluid. Both kidneys were palpable. The pathologic diagnosis was bilateral tubo-ovarian cysts; glandular hyperplasia of the endometrium. Diagnosis: uterus bicornis, unicollis; bilateral tubo-ovarian cysts.

CASE XIII. E. W., a twenty-one year old married woman, gravida 4, para 2, was admitted because of vaginal bleeding (incomplete abortion, ten weeks). Menarche was at the age of thirteen. She had no dysmenorrhea and her periods were regular, every twenty-eight days. Past history revealed that the patient had undergone left salpingo-oophorectomy, and dilatation and curettage for incomplete abortion. She had had hypothyroidism and two full term deliveries, one of which was in breech presentation.

Physical examination revealed no abnormalities. On pelvic examination twin cervices were present. The right cervical ostium was dilated and bleeding. The uterus felt diffusely enlarged and of normal contour. The patient was Rh positive and the basal metabolic rate was −10.

Dilatation and curettage was performed. The left uterine cavity appeared hysterometrically to be hypoplastic. The pathologic diagnosis was abortion, with decidual remnants. Diagnosis: uterus septus duplex causing two abortions and one term delivery in breech presentation.

CASE XIV. A. P., a forty-three year old married woman, gravida 0, para 0, had cholelithiasis. She had never menstruated and had normal sexual relations. Both of her sisters had children.

Physical examination revealed no abnormalities. The secondary sex characteristics were normal. On pelvic examination there was a single, almost full length vagina, which ended blindly. The cervix was absent and no pelvic organs were palpable. Laboratory findings were normal, as was the intravenous pyelogram. Gallbladder series showed multiple calculi.

Cholecystectomy was performed. On exploration of the pelvis only a thin, string-shaped organ was palpable, compatible with uterus solidus. This was not removed. Diagnosis: uterus solidus.

CASE XV. F. B., a twenty-four year old married woman, gravida 1, para 1, had pelvic and premenstrual pain. Menarche was at the age of fourteen. Her periods were irregular. We learned that when the patient was pregnant seven and one-half months she went into active labor and was delivered of a premature, living child by cesarean section. At operation she was found to have two completely separated uteri. There was a fetus in the right uterus. The left uterus was of normal size. The family history was non-contributory.

On pelvic examination a full length vaginal septum was present and there were two completely separated cervices. The left cervix appeared markedly stenotic. Both uteri felt normal in size and contour. Laboratory findings were normal. The patient was Rh positive. Intravenous pyelogram showed no abnormalities.

Dilatation and curettage were performed in both uteri. The pathologic diagnosis was proliferative endometrium. Diagnosis: uterus didelphys with cervical stenosis, left.

In addition to these fifteen proved cases there were two cases in which, on bimanual pelvic examination, uterus bicornis unicollis was diagnosed but not confirmed by follow-up roentgenographic procedures or laparotomy. These two cases therefore are not included in this series.

## COMMENTS

In this series of fifteen proved cases of uterine duplicity we found five cases of uterus bicornis bicollis, in which four patients had incomplete vaginal septa, three cases of uterus bicornis unicollis, two cases of uterus septus duplex, three cases of uterus subseptus and one case each of uterus didelphys and uterus solidus. Six of the fifteen patients had a persistent vaginal septum; and of nine patients in whom urographic examinations were made, three showed absence (aplasia) of one kidney. The left kidney was absent in two cases and the right kidney in one case; in neither case of renal aplasia was there associated homolateral genital aplasia (uterus unicornis or rudimentary horn). Case VII is of extreme interest embryologically inasmuch as the presence of the mesonephros with absence of a metanephric anlage was proved histologically. Further associated anomalies were rectovesical ligament and bilateral cervical ribs (Case I) and vaginal atresia (Cases III and XIV). Seven of the fifteen patients were absolutely sterile. However, three had

used contraceptives at one time or another; in three others sterility was the chief complaint; one patient had lifelong amenorrhea. The eight remaining patients had been pregnant a total of twenty-four times, resulting in seven abortions, one premature and six immature deliveries, and ten full term babies, of which four were delivered by cesarean section. The remaining six babies were delivered by the vaginal route without complications. Of the ten full term deliveries, seven were vertex, two breech and one in transverse presentation. Pregnancy occurred in the left and right horns equally. Hematometra and hematosalpinx were present in two cases (Cases III and VIII), and internal endometriosis of the septum and uterine cornu was present in one case (Case IV). One patient menstruated from the non-pregnant horn during the fifth month of gestation and two patients passed decidual casts. Cesarean section was performed four times (three patients), and on each occasion the non-pregnant horn was noted to be enlarged approximately three times the normal size and in one case was obstructing the birth canal. There were no fetal abnormalities. In ten patients the menstrual periods were regular; three of these patients had cycles of thirty-two to thirty-five days. Four patients had irregular periods and one had lifelong amenorrhea. Eight had moderate-to-severe dysmenorrhea and two had dyspareunia as associated complaints. We believe that our clinical incidence of uterine anomalies of 0.2 per cent is as reliable a figure as can be obtained from a hospital series, although this series, as well as a few others previously mentioned, is too small to be statistically significant. Furthermore, the nature of this condition would make comparison with so-called "unselected" series impossible, apart from the fact that no such series have been published.

## SUMMARY AND CONCLUSIONS

1. Congenital uterine anomalies occur much more frequently than the figures usually quoted in the literature would indicate (1:1500–1:2000).

2. The relative frequency of uterine anomalies in general and their respective types in particular is best established from hospital statistics. Few such statistics have been published.

3. Fifteen cases of uterine anomalies are reported and analyzed, giving a clinical incidence of 0.2 per cent or one in every 500 patients, which is in agreement with the figures reported by Moore [*19*], Kimura [*15*], and Fenton and Singh [*7*].

4. Uterine anomalies are associated with a high ratio of abortions, immature deliveries, malpresentation and sterility.

5. Urographic examination should be made in all cases of proved or suspected uterine anomalies.

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*We recommend:*

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# Primary Carcinoma of the Fallopian Tubes

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MALIGNANCY of the female genital tract is prevalent; however, new growth of the fallopian tubes is rarely present. Carcinoma of the fallopian tubes, as reported by various writers, is found in approximately 0.3 to 0.6 per cent of all gynecologic surgery. Its incidence is so rare that it is encountered by very few surgeons.

The reasons for presenting this case are threefold: (1) to stress the necessity of differential diagnosis at operation so that adequate and thorough surgical management may be carried out, as this condition may resemble simple hydrosalpinx; (2) to appreciate that the associated hydro- or pyosalpinx may be harboring a focus of infection; and (3) to stress and encourage early diagnosis and early surgical extirpation to decrease the mortality rate in this disease.

After two years the patient herein reported on is in excellent physical condition. I attribute the satisfactory result thus far to the routine physical survey and early diagnosis by the internist, who sought the etiologic factor in the recurrent acute iritis in this patient. The pathologic condition of the pelvis presented almost no symptoms.

It is generally conceded that the first authentic report of primary carcinoma of the fallopian tubes was made in 1888 by Orthmann [*1*]. Although this condition had been described previously, the records are not conclusive that the carcinoma was primary rather than metastatic or from direct extension. There were undoubtedly many unreported cases previous to 1888, but it is interesting to observe that since that time only 501 case reports have appeared in the literature. Shortly after 1888 single case reports were recorded [*2–5*]. In 1901 LeCount [*6*] reviewed twenty-one cases, noting the common association of hyperplastic salpingitis. In 1911 Franque [*7*] and in 1917 L'Esperance [*8*] pointed out the frequent occurrence of tuberculosis of the fallopian tubes either in association with carcinoma or as a possible etiologic factor. Several excellent compilations have appeared throughout the years by Wechsler [*9*], Liang [*10*], Vest [*11*], Wharton and Kroch [*12*], Harms [*24*] and Robinson [*23*]. Single case reports were recorded by others [*13–26*]. Thirteen additional new cases were reported between the years 1951 to 1954.

## INCIDENCE

Primary carcinoma of the fallopian tubes is an extremely rare condition found in approximately 0.15 per cent of all hospital admissions, in approximately 0.5 per cent of carcinomas of pelvic viscera and in about 0.3 per cent of gynecologic laparotomies. In 1950 Kamholz [*29*], reporting two cases, quoted an incidence of 0.01 per cent in all gynecologic admissions.

The frequent association of this condition with tuberculosis of the tubes has been reported. It has also been erroneously diagnosed as tuberculosis [*8*].

The rarity of the disease is not understood, since inflammatory disease is often considered to be a contributory factor in the etiology of carcinoma elsewhere in the body. Although the frequency of tubal inflammation has been greatly reduced in the last decade, inflammation seems to have produced very little carcinogenic effect on the tubal mucosa over the past century, during which time relatively accurate records have been kept.

Although it is stated in the literature that approximately one-third of tubal carcinomas are bilateral, I have not located the case reports for verification.

Wechsler [*9*] states that 66 per cent of the patients with primary carcinoma of the fallopian tubes are between the ages of forty-five and fifty-five years. The disease has been reported in patients from eighteen to eighty

years of age. The patient herein reported on was sixty-five years old.

### SYMPTOMS AND DIAGNOSIS

Preoperative diagnosis is rarely made, probably due to the rarity of the condition and the variable signs and symptoms. The most constant symptom is leukorrhea, as recorded by Lofgren and Docherty [30] and many other authors. In younger women it is reported as intermenstrual and in older women, continuous with occasional sudden gushes of vaginal fluid. Irregular-to-continuous bleeding soon appears and numerous reports in the literature have stressed the continuation of leukorrhea and metrorrhagia following diagnostic curettage.

Pain, low in the pelvis on the side of the diseased tube, is a moderately late complaint, usually appearing later than the original symptom of leukorrhea. Its severity probably depends on the distention of the tube either due to carcinoma or purulent exudate of secondary infection.

Bearing-down sensation in the pelvis, backache, constipation and rectal or bladder complaints are late sequelae and are in direct proportion to the size of the mass, its infiltration or its metastasis

The physical finding of a palpable mass in the adnexa is quite constant, which may be barely detectable or may completely fill the pelvis. The mass is rarely tender and its presence or characteristics give no clue as to its etiology.

In 1898 Falk [31] correctly diagnosed this condition by studying fluid aspirated from a pelvic tumor through the cul-de-sac. Today we are fortunate to have a rather reliable diagnostic aid for many types of pathologic conditions of the pelvis, and a cytologic study should be made in all cases of chronic leukorrhea and abnormal uterine bleeding.

Finally, pelvic laparotomy is always indicated for pelvic tumor in a woman in this age bracket who is bleeding or who has unexplained, severe leukorrhea.

Because of its lethal characteristics this condition must be treated with every available method. The minimum treatment must consist of total abdominal hysterectomy with bilateral salpingo-oophorectomy. At this point I must stress the necessity of sectioning all diseased and distended fallopian tubes at operation; siplem salpingectomy should not be performed for carcinoma of the tubes. In addition it is desirable to perform bilateral node resection and resection of any demonstrable metastases. The patient should be referred to the radiologist for further therapy.

### PATHOLOGY

Parous and non-parous women are about equally susceptible to primary cancer of the fallopian tube. It occurs with approximately equal frequency in both right and left tubes. Its spread may take place by direct extension across the fundus of the uterus, by transperitoneal migration or by hematogenous or lymphatic metastasis.

The early local pathologic condition usually occurs in the outer two-thirds or the most distensible part of the tube. The swelling is often referred to as club- or sausage-shaped. The fimbriated end of the tube is most frequently sealed and often densely adherent to the ovary. The tube presents the appearance of chronic salpingitis or hydrosalpinx in the earlier phase of the disease. As the disease progresses the tube attains a size of 6 to 8 inches in diameter with adhesions to all contiguous organs. This great size is augmented by the association of hydrosalpinx or hematosalpinx. In contradistinction to metastatic carcinoma of the tubes, the serosal surface is rarely involved. In this disease the ostium of the tube closes early, attaching itself to the homolateral ovary and probably accounting for the rarity of carcinomatosis of the pelvis [14], which is reported in approximately 5 per cent of cases.

Microscopically, malignancy of the fallopian tube may be of three cellular structures [31]: papillary, adenomatous or alveolar. In many instances various combinations of these cellular patterns are seen in the same patient. Papillary carcinoma is the commonest primary type and may arise from benign papillomas or from the mucosa. The adenomatous type is more apt to penetrate to the serosal layer.

The epithelial cells are usually multilayered with a thin stroma. The cells are irregular in size and shape, with large nuclei and without uniform staining qualities. Vacuolization of the cells is common and mitosis frequent. The alveoli are filled with hyalin secretion. Lymphocytic infiltration usually occurs and occasionally areas of necrosis are present. The papillae

enlarge, press together and form solid masses of tumor.

Tuberculosis may produce an adenomatous structure closely resembling the picture of carcinoma.

### PROGNOSIS AND TREATMENT

The prognosis of carcinoma in this location is extremely poor due to: (1) late diagnosis; (2) the high grade of the malignancy, especially in the alveolar form; (3) early invasion of lymph and blood channels; and (4) frequently incomplete therapy. Fullerton [33] stresses the decreased mortality rates with more complete surgery. Lipschitz [34] reported only four five-year cures in 122 cases. Graves [35] estimated the five-year cures at not over 4 per cent. It becomes obvious that the total rate of cures is very low and in 25 per cent of these cases recurrence is usually current within one year.

Our only satisfactory therapy at present is radical surgery, consisting of panhysterectomy and bilateral salpingo-ovariectomy and wide lymph node resection, and x-ray therapy to tolerance.

### CASE REPORT

C. F. J. (File No. 81919), a sixty-five year old married woman, appeared for routine physical examination only because of extremely acute attacks of recurrent iritis in the left eye. She had no symptoms of abdominal or pelvic disturbance, no abnormal bleeding or vaginal discharge. She had undergone hemorrhoidectomy and vein ligation four years previously. She had had pneumonia forty-five years before and had had rheumatic fever as a child. During the six months before the present admission she had had attacks of cystitis and iritis.

The patient's father had died at the age of seventy-two with asthma and carcinoma of the nose. Her mother was living, at the age of eighty-six. Three siblings had died, one of peritonitis, one of pneumonia and one of eczema; one was living and well. There was no family history of diabetes, tuberculosis or kidney disease.

Because of the acute iritis the patient had visited her internist who made a routine physical examination and referred her to a gynecologist for pelvic examination, at which time she was told there was a possible small swelling in her pelvis. She returned to me for confirmation of the diagnosis. I found a small, hard, rather fixed mass approximately 2 to 3 inches in diameter in the left adnexa. It was not tender; but since I believed it might represent the source of infection, I advised removal. She was immediately admitted to the hospital for this treatment.

On physical examination the patient's blood pressure was 200/100, pulse 86 and respiration 18. Her head was symmetric and there was no tenderness; the eyes revealed no evidence of disease. The iritis was completely quiescent; ears, nose and throat were normal; the neck was normal; the thorax was symmetric with normal expansion and no adventitious sounds; the heart was normal except for systolic murmur and some enlargement to the left. The breasts were normal. The abdomen was symmetric with no evidence of tenderness; no enlarged organs or masses were palpable. Normal bowel sounds were present and general examination of the abdomen appeared normal.

Extremities showed evidence of previous vein ligation but were otherwise normal. Pelvic and rectopelvic examination revealed a normal cervix; the fundus was normal in size, shape and position; the right adnexa was normal; in the left adnexa there was a small mass approximately 2 to 3 inches in diameter, firm, quite fixed and rather tender, which appeared to be a tubal or ovarian mass.

Rectal examination revealed normal sphincter tone, no particular hemorrhoids and a normal ampulla.

The diagnosis was tubal ovarian mass, hypertension and iritis in subsiding stage.

Laboratory reports were as follows: urine specific gravity 1.007, albumin and sugar normal, white blood cells 0 to 1, epithelial cells few; red blood cell count 4,050,000 per cu. mm.; white blood cell count 7,200 per cu. mm.; hemoglobin 12.1 gm. per cent; color index 0.9; differential count: juvenile cells 1, stab forms 1, segmented cells 58, lymphocytes 35 and monocytes 2.

The operative report was as follows: Due to the mass in the left adnexa and bouts of iritis, pelvic laporatomy was performed. The patient was draped in the usual manner under general anesthesia and a left paramedian incision was made in the left lower abdomen. Exploration of the abdomen revealed all the organs and upper abdomen, including liver, aortal glands, stomach, spleen, and diaphragm

FIG. 1. Gross section fallopian tube.

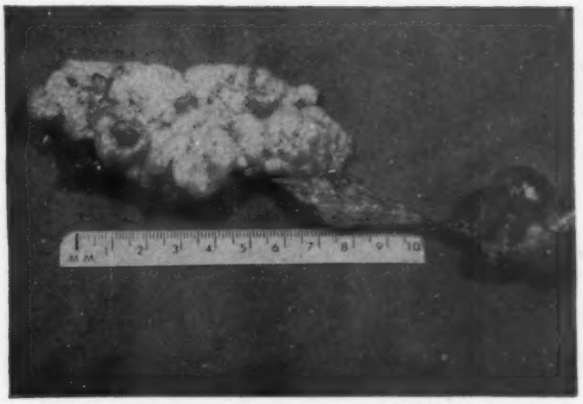

FIG. 2. Gross section fallopian tube excised.

to be normal. There were a few adhesions in the pelvis; and bound down in the pelvis in the left adnexa was a mass approximately 2½ inches in diameter, which appeared to be a hydrosalpinx. The wall of the hydrosalpinx was extremely firm and rigid and appeared to be a chronic process and unusually thickened for a hydrosalpinx. Bilateral salpingo-ovariectomy and total abdominal hysterectomy were performed.

The vaginal cuff was sutured with continuous catgut and the uterosacrals were sutured to the pubocervical fascia. The round ligaments were sutured into the vault, and the area was peritonized with continuous catgut. Appendectomy was performed in the usual manner; the stump was inverted under purse-string suture after being cauterized with phenol and alcohol. The peritoneum was closed with continuous catgut; the fascia was closed with interrupted cotton, and the skin, with interrupted dermal sutures. The patient was returned to her room in excellent condition.

The pathologic report was as follows: The left tube was slightly tortuous. In many instances fine fibrous adhesions held it together so that it assumed the previously described characteristic pattern; it measured 8.6 by 3.3 cm. at its greatest diameter. The tube was somewhat grey-yellow in some areas and red in others. Vascular markings were accentuated, while the serosa itself was smooth, glistening and grey-tan. Sectioning of the tube revealed a wall which measured 0.1 cm. and presented as a papillary, grey-tan, necrotic appearing mass. There was a tumor, approximately 6 by 3.5 cm. in diameter, incorporating the tube. The serosa for the most part was smooth, glistening and grey-red in color which did, however, present an oval, yellow, nodular tumor, measuring 0.4 cm. on its surface. The ovary was somewhat oval, lobulated and grey-white in color and measured 1.9 by 1.1 by 0.6 cm. Located along the course of fibromembranous tissue, which was attached to the tube, was an oval, grey-white nodular mass measuring 0.6 by 0.8 cm. At the edge of the fibromembranous fatty extension was a serous-filled tumor, measuring 2.1 by 2.1 cm. in diameter, which had a clear, smooth surface and smooth lining. The appendix appeared to be normal.

Microscopic diagnosis was as follows: (1) Moderately rapid-growing papillary adenocarcinoma of apparent primary origin in the left fallopian tube. The lesion revealed obvious papillary surface tendencies and was continuous with a similar type of acidophilic, anaplastic-appearing epithelium, lining almost the entirety of the tube. As the tumor invaded the tubal wall, it assumed a solid medullary type of growth and was apparent in the immediate aspect of the perisalpinx. (2) Benign paraovarian cyst of the mesosalpinx. (3) Chronic pyosalpinx. (4) Atrophic ovaries. (5) Leiomyoma of the uterus. (6) Atrophic senile endometrium. (7) Adenomyosis, uterus. (8) Marked chronic cervicitis. (9) Nabothian cyst.

This patient had an uneventful convalescence and returned home at the end of ten days. She has had no further attacks of iritis and no further symptoms of a pathologic condition of the pelvis. At the time of this reporting, almost two years later, she is in excellent health and has no evidence of recurrence of this carcinoma.

The gross specimens and microscopic sections are shown in Figures 1 to 3.

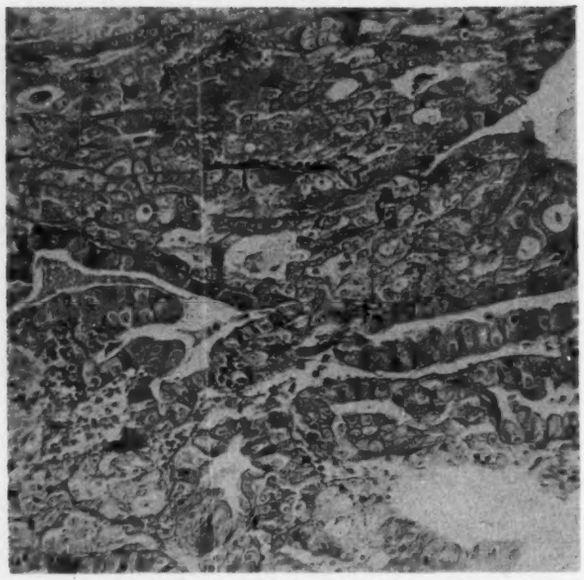

FIG. 3. Microscopic section fallopian tube.


SUMMARY

1. It becomes apparent that the pyosalpinx associated with the tubal malignancy in this patient must have been the etiologic factor, precipitating her recurrent attacks of iritis.

2. Early diagnosis must be stressed if our mortality is to be reduced. I believe the case reported herein was diagnosed and treated in its early asymptomatic stage, as it was discovered in a routine physical examination, and the patient is still in excellent physical condition after two years.

3. Carcinoma of the fallopian tube is rarely diagnosed preoperatively.

4. Early symptoms of carcinoma of the tubes are irregular vaginal bleeding or postmenopausal spotting and intermittent or continuous, watery vaginal discharge, often in gushes.

5. The preoperative diagnosis, unfortunately, is usually benign tumor of the fallopian tube and, consequently, surgery may be delayed until pain occurs or until such time as the patient finds it convenient to be hospitalized.

6. The disease is usually advanced when first seen or first diagnosed. The diagnosis is usually made at operation but may be missed even here, assuming the condition to be a hydrosalpinx. The specimen should be sectioned at operation.

7. The disease usually affects women at or near the menopause. It occurs in approximately 0.1 to 0.3 per cent of all operations on the female genitalia. It is bilateral in approximately one-third of cases.

8. The surgical treatment is frequently inadequate. These patients are rarely cured.

9. There are probably many cases which have not been reported in the literature.

10. In past years inflammation of the fallopian tubes has been very common, yet carcinoma has been extremely rare. It would seem that inflammation has no carcinogenic properties in this portion of the anatomy.

11. In recent years we have added an excellent diagnostic aid, that of cytologic study.

12. Treatment should be: (A) Total abdominal hysterectomy. (B) Bilateral salpingo-ovariectomy. (C) Wide resection of metastatic noted. (D) Postoperative roentgen therapy.


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Elderly and poor risk patients with hyperthyroidism will often do well on radioiodine (I-131); also patients in whom the hyperthyroidism recurs after surgery. Some patients absolutely refuse surgical therapy and others are hypersensitive to the usual antithyroid drugs. In such instances I-131 is definitely indicated and the majority of patients will be greatly benefited. Over 80 per cent will have a complete remission after only one or two doses of radioiodine. Some authors believe that I-131 is contraindicated in the therapy of hyperthyroidism in children, or in the pregnant patient, and probably when it is associated with an easily removable, solitary nodule. One must watch the basal metabolic rate after such therapy because in approximately one-fifth of the patients hypometabolism develops. (*Richard A. Leonardo, M.D.*)

# Vaginal Plastic Surgery Based on a New Concept of the Anatomy of the Female Genital Tract

## I. AN INTRODUCTION

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THE general plastic surgeon, in his efforts to restore normal anatomic conditions, is guided by his knowledge of the normal anatomy of the particular area with which he is dealing. The vaginal plastic surgeon is not so fortunately placed. He finds himself in an anomalous situation because the actual normal anatomy of the female genital tract has never been correctly presented. That is a rather strange assertion to make, but it is a fact nevertheless. The textbook descriptions are not true to life. They are based on cadaver dissections of ancient, dilapidated females, and do not bear the slightest resemblance to the normal. What is the normal anatomy of the female genital tract?

In this paper an attempt will be made to "demonstrate" the normal anatomy of this region as it is found in the living, undamaged, human female, based upon clinical observation and experience. This "demonstration" can be duplicated and verified by every practitioner in his own office, and especially by gynecologists and obstetricians who so frequently have occasion to examine such patients.

Let us assume that an undamaged young woman, twenty to twenty-five years of age, a nullipara or perhaps a primipara, consults an obstetrician about the possibility of an early pregnancy. She is placed on the examining table in lithotomy position with the vulva exposed, and the regular, systematic examination is begun.

Upon separating the labia, the orifice of the vagina is exposed. It is, of course, relatively small; and upon insertion of one finger, a certain amount of resistance is encountered. What causes this resistance? The textbooks make cursory mention of a sphincter vaginae but generally no particular attention is paid to it. Certainly, no cognizance is ever taken of it in any of the vaginal plastic procedures. Then, again, that there is a dense fascia underlying the sphincter is entirely ignored; yet it is perhaps the more important element in the resistance mentioned.

To proceed with the examination, the finger, having penetrated the orifice, dips down suddenly into a definite space which is directed downward and backward toward the lower rectum and at the same time extends laterally on each side.

The finger is turned around and up, passing the orifice of the vagina, and comes in contact with the posterior surface of the pubis and its rami. In the median line a fine cord-like structure can be felt, the urethra. Continuing, another space is entered, the anterior fornix. Then the finger impinges on a conical-shaped structure, the cervix uteri.

If the examination is ceased momentarily at this point and the finger is swept around once or twice so as to traverse the area just described, the following is noted: (1) the area is a rather wide and expanded part of the genital tract; (2) it is somewhat circular or disc-shaped; (3) it is in a plane practically parallel with the anterior pelvic wall; and, (4) its shape, position and relationship are suggestive of a sort of anteroom or vestibule to the rest of the tract to be described presently. For the purpose of orientation, it will be designated as the intravaginal vestibule of the vagina.*

* This is not to be confused with the vestibule of the vulva, which is, of course, outside the vagina.

The vaginal wall hugs the upper part of the cervix and then extends for a variable distance under the expanding part of the uterus to form the posterior fornix. The vaginal wall now takes a slightly upward direction and extends along the posterior surface of the lower part of the uterus to a point slightly above the level of the sacrouterine ligaments, and then curves sharply backward and downward, becomes covered with peritoneum and forms the vault of the vagina.

Continuing downward for some distance, the posterior vaginal wall becomes part of the anterior wall of the cul-de-sac of Douglas.

Farther down, the posterior vaginal wall is attached to the anterior wall of the rectum. Then, as the rectum begins to deviate backward, the vaginal wall follows the same curve; and thus is started the formation of the space mentioned previously, when the finger had just penetrated the orifice of the vagina and dropped down into this space. It is essentially the lower part of the intravaginal vestibule, as was the anterior fornix of the vagina in its upper part. This lower space will be referred to hereafter as the inferior fornix.

Down in the depth of the inferior fornix, there is a definite line of demarcation which divides the posterior or descending wall of the fornix from the anterior or ascending wall. This line is firmly attached to the subjacent structures and marks the point of departure of the rectum from the vagina.* This line of demarcation will be referred to as the commissure of the inferior fornix, and its importance will be brought out in a future paper on rectocele.†

From the aforementioned description, it must be quite apparent that the posterior vaginal wall is not just a continuous flat surface, but actually forms a Z-shaped curve, the several parts of which are at various angles to each other, which in turn are in definite relationship to the adjacent organs and structures. Furthermore, the vagina, considered as a whole, is not the simple straight tube as described in textbooks, but is rather a composite organ; the expanded part immediately behind the orifice, the intravaginal vestibule, and then the succeeding part, extending from the vestibule upward and backward in a somewhat tubular fashion. Obviously, these two distinct parts are in different planes and practically at right angles to each other. The importance of this will also be brought out when the treatment of certain birth canal injuries is discussed.

The cervix, the urinary bladder and the urethra are in such close proximity that they may be regarded as intimate parts of the female genital tract.

The cervix penetrates the anterior vaginal wall only a short distance from the pubis in the undamaged woman, and separates the anterior from the posterior fornix. The anterior fornix is a relatively small compartment.

The anterior fornix, being what it is, permits only a very small part of the bladder to rest upon it. This is contrary to the impression one receives from the illustrations in textbooks.

The urethra has its beginning in the vestibule of the vulva, passes under the arch of the pubis and, as it enters the pelvis, makes a bend upward and becomes deeply imbedded in the anterior vaginal wall; the latter, in turn, is attached firmly against the posterior surface of the pubis. The urethra is placed in the median line and is in contact with the symphysis pubis, and then merges with the bladder. Therefore, the urethra in its course is in the form of a rectangle and is not the straight tube one may think it is from illustrations.

The time and space devoted to so small a portion of the human anatomy will, no doubt, appear trivial and inconsequential to some. Actually, however, this represents many years of study, observation and contemplation. The significance of stressing the details of the actual normal anatomy of the female genital tract will be realized when operative procedures for the correction of certain birth injuries by vaginal plastic surgery are brought into focus.

## CYSTOCELE

The term cystocele has been used for such a long time that it is almost a sacrilege to declare it a misnomer. However, effective treatment of this condition cannot be accomplished unless we abandon the present concept of its pathology, which the name implies.

Cystocele means bladder hernia and therefore all operative procedures had been directed or rather misdirected, toward the "cure" of

* Externally, a pyramid-shaped structure is thus formed which is referred to by anatomists as the perineal body.

† This commissure can be visualized in the normal case only by the use of a flat retractor. The ordinary speculum will not reveal it.

this "hernia." But, is there really a hernia of the bladder?

Hernia, by definition, is a protrusion. That implies a protrusion of an organ through a defect in an intervening or a supporting anatomic structure. In this case, the supporting structure would be the anterior vaginal wall. However, anyone with experience in this field must know that there is no defect in the vaginal wall *per se* in these cases to permit anything to protrude through it. True, part of the bladder is at a lower level, but that is only due to the fact that the supporting vaginal wall had been displaced and is at a lower level, and part of the bladder had been pulled down with it but not through it. What then is the pathology of this so-called cystocele?

Here the concept of the normal anatomy gives us the clue. Normally, as has been indicated previously, part of the anterior vaginal wall is attached to the posterior surface of the pubis and its rami; but in difficult, prolonged labors, the vaginal wall may be torn away from its attachment to the pubis. In other words, there is an avulsion of part of an organ from its bony attachment. The result is a loose-hanging vaginal wall, as represented in this so-called cystocele. Another factor to be borne in mind is that the anterior fornix is no longer present.

*Treatment of Avulsion of the Anterior Vaginal Wall.* The conventional cystocele operation, which consists of excision of part of the loose vaginal tissue and puckering up the vagina with a few sutures, does not treat the condition etiologically and does not restore normal anatomic conditions. The following is a brief sketch of what the operative treatment should be.

With two fingers of the left hand, the hand in supination, the loose anterior wall is pushed up along the pubis to about the level of its crest. Then the apex of the vaginal wall, between the two fingers, is grasped with an Allis clamp and is brought down. The clamp marks the area of the vagina to be attached to the pubis and its rami. A loose suture on each side of the clamp may be used as markers and the clamp is removed.

A median incision is made and lateral flaps developed, as in the usual cystocele operation, but no vaginal tissue is excised. The bladder is catheterized and a sound passed to determine the position of the urethra.

With a narrow, lateral retractor, the bladder is lifted up high so as to be out of the way, and the pubis and rami are palpated to obtain a mental picture of the anatomic points to be dealt with. A small, full-curve cutting edge needle is threaded with a fine silk suture and a horizontal bite is taken in the periosteum. A similar submucous bite is taken in the lateral vaginal flap on that side, but is not tied. A similar suture is taken on the other side. Additional similar sutures may be needed on each side. Each suture is pulled up in turn to see how well the vaginal wall has become adapted to the bony surfaces. A number of interrupted chromic sutures are taken submucously, vertically and deeply, in order to catch the fascia, until the cervix is reached; the flaps are then brought together in the median line. All sutures are tied. A continuous chromic suture closes the wound, and the operation is completed.

What has this procedure accomplished? (1) The suture is not a straight line but is rectangular. (2) The architecture of the anterior fornix has been reconstructed. The cystocele has been eliminated. (3) The cervix is in a high position, pointing backward, and is not very far from the pubis. (4) The urethra may be felt in the median line against the symphysis. (5) There was no "redundant" vaginal tissue to be excised.

# Simplification of Anal Fistulectomy Based on Surgical Anatomic Factors

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ADEQUATE fistulectomy precludes accurate knowledge of the etiology, pathology, differential diagnosis and surgical anatomy of anorectal infection. Surgical anatomy is the most important factor. Approximately 5,000 consecutive proctologic patients constitute the basis of this study.

Review of the literature indicates inadequate information concerning simplified surgical anatomy. The experienced surgeon recognizes the external sphincter muscle as one entity and his results do not depend on the knowledge that this muscle consists of three parts with separate fascial planes. This is but one example.

The surgeon is interested in the eradication of disease and the prevention of incontinence. The entire fistulous tract must be removed and the anorectal ring allowed to remain intact. There are certain fundamental principles which simplify treatment.

Surgery for anorectal fistula and its related anatomy can only be learned at the operating table. It is indeed a rare fistula which requires complete severance of the anorectal ring for cure. This is the principle of paramount importance. Practically all fistulas have their origin at the level of the crypts which are just to the anal side of the anorectal line. Palpation in the living subject reveals that the bulk of the anorectal ring lies above the crypts. This principle cannot be appreciated by study of cadaver or even operative specimens. Study of hundreds of such specimens relative to other phases of anorectal investigation has substantiated this statement.

The anorectal ring consists of external and internal sphincter and levator muscles. It can easily be palpated.

## ETIOLOGY AND PATHOGENESIS

An abscess in the anorectal area, as elsewhere, is a localized area of infection which culminates in the collection of purulent material. Such infection is more frequent in males in the ratio of 2:1.

Staphylococcus, streptococcus and coliform organisms are usually found in abscesses. Occasionally pyocyanus, proteus, actinomyces, tubercle bacilli and gonococcus are found.

The abscess shows a necrotic wall consisting of inflammatory cells and fibrous tissue with a central core of pus and bacteria. A fistulous tract reveals a lining of granulation tissue, usually richly infiltrated by small round cells and plasma cells. The outer wall is usually composed of fibrous tissue.

The direct or exciting cause of anorectal infection is the entrance of pyogenic bacteria in the adjacent loose areolar tissue. By virtue of the arrangement of the crypts of Morgagni, normally found at the anorectal line, approximately 90 per cent of the abscesses have their origin here. A recent study has amply confirmed previous observations that epithelium-lined ducts are to be found in human embryos and adults. These ducts may provide pathways for spread of infection and it is conceivable that pararectal abscesses might have such a pathogenesis.

The majority of abscesses result in fistula formation. The site of origin is termed the primary opening, and the terminal end the secondary opening. There are four stages in the development of a fistula. Inflammation in a crypt of Morgagni (cryptitis) occurs first. The infection then burrows through the underlying tissues, probably in the anal ducts or periductal lymphatics, thus constituting the second stage of this process. The third stage is the establish-

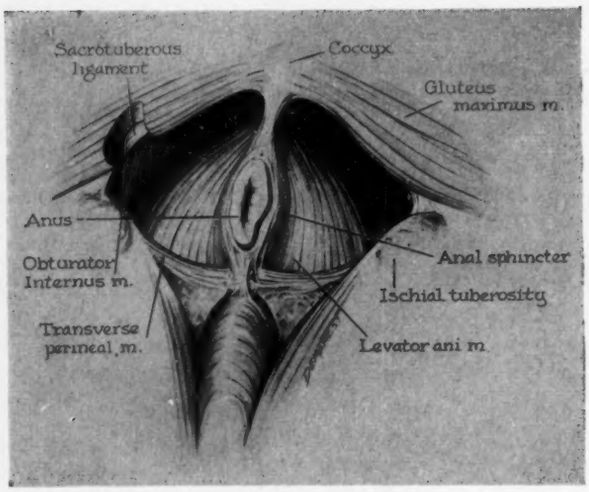


FIG. 1. Ischioanal fossae.

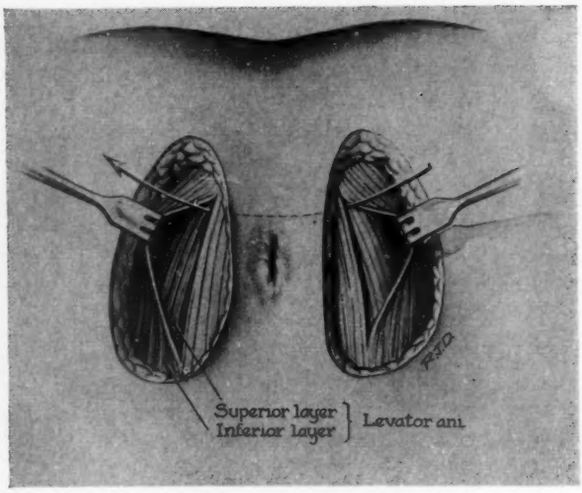


FIG. 2. Posterior levator space.

ment of an abscess. The final or fourth stage is the spontaneous or surgical opening of the abscess. The fistula may drain continuously or intermittently, in which case recurrent abscess formation would be possible.

There are instances in which, for some reason or other, the abscess is not opened and drainage occurs in retrograde fashion through the primary opening, thus constituting an incomplete or "blind" fistula.

Generally, in a given case, only one primary opening is present. When more than one is found, it is probable that it represents an additional secondary opening at which site the abscess has eroded through the tissues of the anorectum. In contrast, it is not unusual to discover two or more secondary openings.

The indirect or predisposing causes of abscess and fistula include the following: malnutrition, diabetes, tuberculosis, malignancy, dysentery, regional enteritis, chronic ulcerative colitis, perianal dermatitis, retrorectal tumors and cysts, osteomyelitis of the pelvic bones, pelvic abscesses, prostatitis and vesiculitis, trauma, presence of a foreign body and malformations. It should be emphasized that these constitute the relatively rarer causes of infection.

## ANATOMY

Localization of an abscess may occur below or above the levator ani muscles. If it occurs below the levator muscles, the abscess should be classified further as ischioanal, perineal, posterior levator or postanal (subsphincteric). If it occurs above the levator, it should be identified as either retrorectal or pelvirectal. These abscesses may occur as a combination of two or more of these types, and for this reason anatomic knowledge is essential to proper diagnosis and treatment.

The ischioanal fossa (Fig. 1) is bounded laterally by the obturator fascia, obturator internus muscle and ischial tuberosity; medially by the internal and external sphincter muscles; above by the levator ani muscle; posteriorly by the gluteus maximus muscle and sacrotuberous ligament and anteriorly by the transversus perinei superficialis muscle and perineal fascia.

Perineal abscesses occur usually subcutaneously, anterior to the transversus perinei muscle.

The superior and inferior layers of the levator (iliococcygeus and pubococcygeus portions) diverge from each other slightly, thereby forming a "V" or wedge-shaped potential space lying against and surrounding the rectum posteriorly and laterally, which has been named by Courtney as the "posterior levator space." (Fig. 2.)

The postanal or subsphincteric space (Fig. 3) is bounded anteriorly by the posterior surface of the deep external anal sphincter, superiorly by the inferior surface of the coccygeal muscular raphe and inferiorly by the decussating fibers of the deep portion of the external anal sphincter as they insert into the skin.

The retrorectal space (Fig. 4) is situated in front of the sacrum, behind the rectum, below the peritoneum and above the levator muscle.

The pelvirectal space (Fig. 5) is bounded above by the peritoneum, below by the levator, behind by the lateral ligaments and rectum

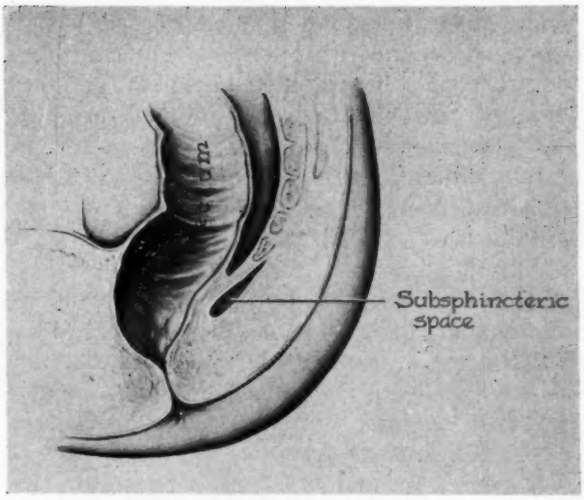


FIG. 3. Subsphincteric space.

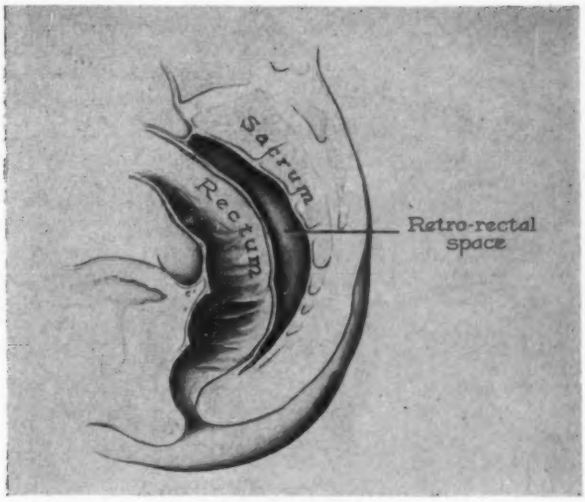


FIG. 4. Retrorectal space.

and in front by the bladder, prostate and seminal vesicles in the male and the uterus and corresponding broad ligaments in the female.

Knowledge of absolute anatomy is not sufficient. Pathologic processes do not recognize anatomic boundaries. The surgeon who can distinguish pathologic from normal tissue is in a position to eradicate a fistulous tract without extensive knowledge of anatomy.

### TREATMENT

Diagnosis and treatment is simplified by dividing abscesses and fistulas into two general groups. The first group of cases, by far the larger, are of local origin and may be treated entirely by local measures. The second group, which represent the unusual type of disease, must be diagnosed and treated locally as well as managing the underlying disease.

Palpation of the indurated or fluctuating area usually makes it possible to identify an abscess as subcutaneous, submucosal, ischiorectal, postanal, perineal, posterior levator, retrorectal or pelvirectal. Inspection aids in diagnosing the external types. Endoscopic examination is necessary in discovering certain submucosal abscesses and both primary and secondary openings of fistulas.

Palpation is best performed by inserting the index finger in the rectum, and then by utilizing the thumb of the same hand all the tissues between the peritoneum above and the skin below may be investigated. (Fig. 6.)

As a general rule abscesses, with the exception of the submucosal type or those pelvirectal

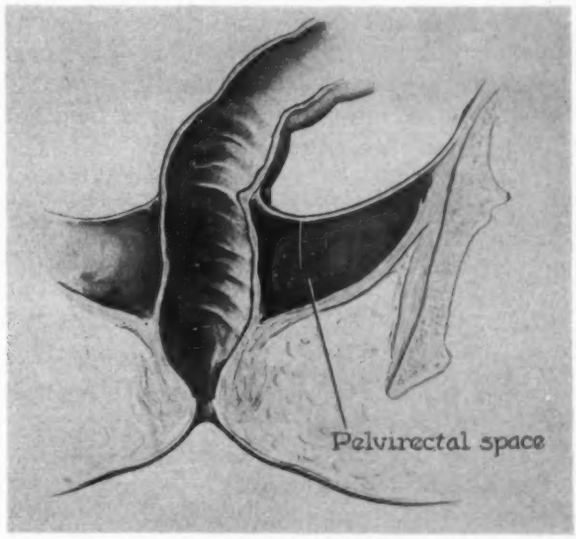


FIG. 5. Pelvirectal space.

or retrorectal, which have partially opened through the rectal wall, are best approached externally well away from the sphincter mechanism. The superficial ones are widely uncapped and gently explored with a finger to break down any inflammatory bridges of necrotic tissue. The pelvirectal abscesses are drained by an incision lateral to the anus, gradually deepening it through the ischiorectal fossa and levator. The retrorectal abscess is approached by an incision just lateral to the anococcygeal raphe. Submucosal abscesses are opened intrarectally and frequently it is possible to extend the incision to the involved crypt and avoid subsequent fistulectomy. The posterior levator abscess is

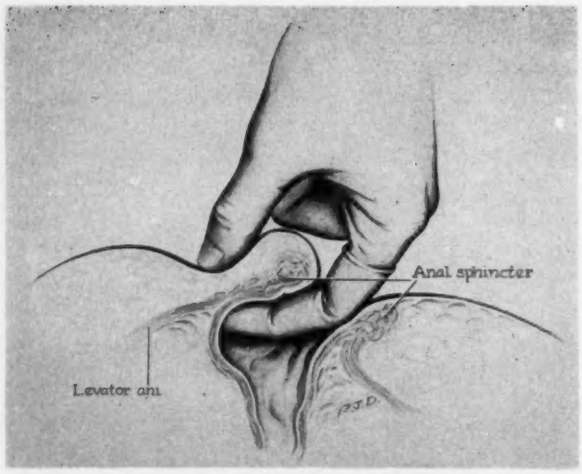


FIG. 6. Method of examination.

opened by an almost horseshoe-shaped incision around the posterior and lateral portions of the anus. In this type of abscess the anococcygeal raphe may be allowed to remain intact as the two limbs communicate with one another through the subsphincteric space. This type of management also applies to the posterior horseshoe-shaped abscess. If the communication occurs superiorly to the bulk of the anococcygeal muscle, a seton suture might be used to advantage.

In many abscesses, providing the primary opening is readily found, it is possible to avoid subsequent fistulectomy by completing the incision to the involved crypt. (Fig. 7.)

Treatment of the inevitable fistula is simplified if one recognizes that with few exceptions the primary opening is found in a crypt. The fistulous tract, beginning in a crypt, may extend submucosally and end in a secondary opening higher in the rectum (Fig. 8) or may extend subcutaneously and end in a secondary opening in the perianal region. It may penetrate any portion of the sphincter or levator muscles and extend through any of the pararectal spaces and then end in a secondary opening or openings in the perianal region. The tract may extend to the groin, buttocks or sacrococcygeal areas. The majority of complicated fistulas have their origin in the crypts of the posterior portion of the anus. The larger group of simple fistulas have their origin in the anterior half of the anus.

Any of these tracts may end blindly before reaching the skin surface or the lumen of the rectum, in which case they are known as sinuses and not fistulas.

The most important factor in dealing with a fistula is to delineate properly its course through the anorectal sphincter mechanism. It is seldom necessary to sever the entire anorectal ring, as there is usually a substantial amount of muscle remaining superior to the tract. Briefly then, the primary opening in the crypt must be found and with the aid of a probe the tract may be followed as it traverses the muscle, the respective pararectal space, subcutaneous or submucosal tissues and finally emerges at a point higher in the rectum or out on the skin surface. All overlying tissue must be cut until the probe lies loosely in the wound. In certain instances when the tract has a sharply angulated course, for instance from a crypt into the supralevator space and then out again to the skin surface, two probes may be used to advantage (Fig. 9), one inserted through the primary opening and one through the secondary opening. Communicating channels must naturally be eradicated.

Mere palpation of a tract or associated indurated tissue above the level of the anorectal ring does not necessarily mean that the anorectal ring must be severed to obtain a cure. In actual practice the bulk of the sphincter mechanism (anorectal ring) is usually bypassed by the tract in one of two ways: either the tract extends from a crypt and superficially traverses the sphincter and then extends superiorly to one of the pararectal spaces, or it does not penetrate the sphincter mechanism at all but extends directly from a crypt superiorly in the submucosal tissue to a point higher in the rectum. Either type of fistula may easily be eradicated without substantial injury to the anorectal ring. This is the principle which simplifies surgery for fistulas.

The wounds are kept open, but not packed, so that complete healing may take place. When one keeps in mind the pathologic appearance of the fistulous tract, it is not necessary to use methylene blue or similar agents to delineate the course these tracts pursue. It is always necessary to be alert and avoid false passage of the probe. One may begin at the primary or secondary opening, whichever is easier. When more than one primary opening is found, careful examination will usually reveal its subcutaneous or submucosal connection with the original one. This is also true in the case of multiple secondary openings.

The smaller or rarer groups of abscesses or

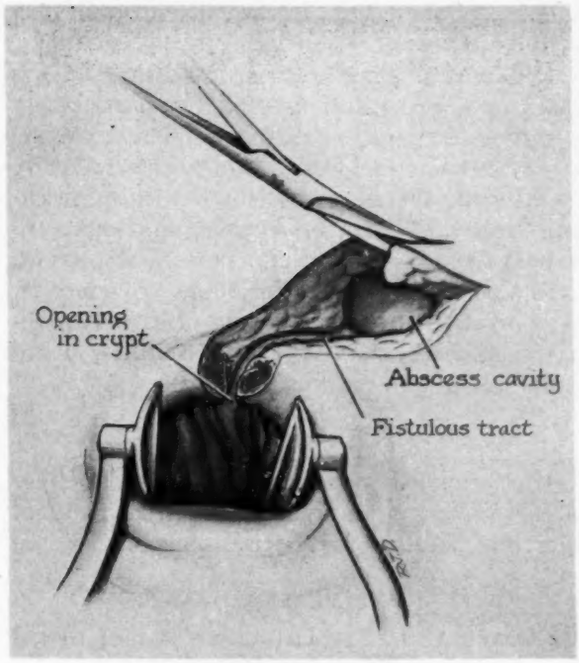


FIG. 7. Simple fistulectomy.

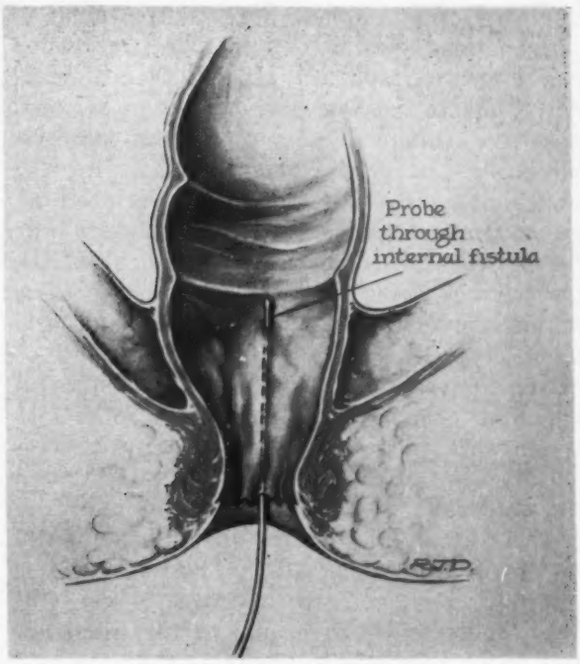


FIG. 8. Rectorectal fistula.

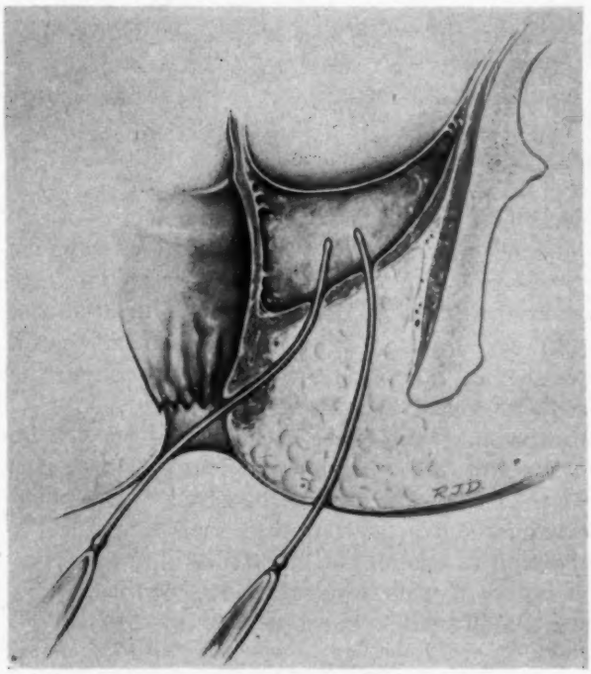

FIG. 9. Angulated fistula.

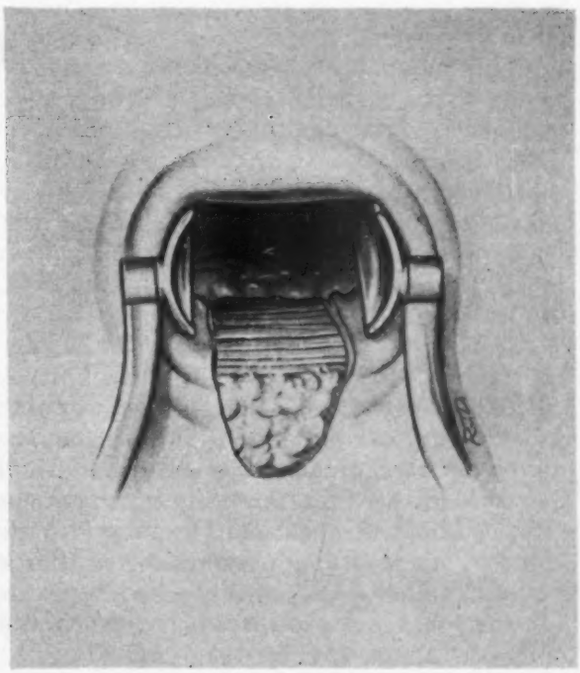

FIG. 10. Management when primary opening is not evident.

fistulas must be managed according to the individual problems presented. A brief didactic review will suffice. Treatment of the underlying disease takes precedence over local therapy in such conditions as pelvic abscesses, chronic ulcerative colitis, regional enteritis, new growths, periurethral abscesses, gonorrhea and tuberculosis. Although it is true that abscesses, regardless of their origin, must be drained, it is not true that all fistulas must be

operated upon at once. Surgical treatment of deep fistulas associated with ulcerative colitis could easily result in incontinence. Surgical correction of fistulas associated with regional enteritis, tuberculosis and actinomycosis is advisable but only when treatment for the underlying disease is instituted. Periurethral, gonococcic, neoplastic or pelvic abscesses may be incised and drained, but treatment of the underlying cause is pertinent to avoiding severe complications such as septicemia or perirectal cellulitis.

Mention should be made of the fistula in which a primary opening is not found. In these cases adequate drainage of the abscess and excision of the crypts in the quadrant of the anal canal in which one would naturally expect to find the primary opening frequently results in cure. (Fig. 10.) Treatment here is somewhat analogous to treatment of the lymphatic abscess which occurs in the perineum and which responds to adequate drainage and excision of the crypts in the anterior quadrant of the anal canal.

Differential diagnosis is important in all cases of abscess and fistula, but particularly in differentiating the rarer types. The following must be considered in addition to those already mentioned: abscesses associated with appendicitis and anal fissure, rectovaginal or rectovesical fistula, pilonidal cysts, retrorectal dermoid cysts, Bartholin cysts, pyodermia, osteomyelitis, penetrating injuries, lymphopathia venereum, congenital dimples, large hair follicles and chromaffin bodies.


## SUMMARY

The etiology, pathology, differential diagnosis, anatomy and simplified treatment of anorectal fistulas have been discussed.


## REFERENCE


1. Kratzer, G. L. The anal ducts and their clinical significance. *Am. J. Surg.*, 79: 32–38, 1950.


Welti and others of the French School studied the long term results of removal of the distal two-thirds of the stomach for gastric or duodenal ulcer in a large number of patients. The operative mortality rate was only a fraction over 1 per cent and ultimate good results were present in almost 80 per cent. One-third of the patients with poor results were benefited by a second operation. The point is that subtotal gastrectomy can produce satisfactory long term results in a large proportion of cases. The literature is filled with many articles illustrating the failure of this surgical therapy; hence the authors believe their study was worth while. (*Richard A. Leonardo, M.D.*)

# Volvulus of the Transverse Colon

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THE term volvulus is interpreted as describing a process in which there is torsion or twisting of a segment of bowel resulting in obstruction of the lumen and disturbance in circulation to the wall of the intestine.

In the etiology of volvulus of the transverse colon the following factors may be considered: (1) Congenital factors: A congenital increase in the length of the transverse colon and its mesentery together with narrowing of the mesenteric attachment easily allows torsion to occur. (2) The aging process: Chronic recurrent constipation associated with senility, weight loss, loss of intestinal tone and visceroptosis have been suggested as causative factors. (3) Adhesive bands: Previous operations and inflammation with adhesions at the base of a long colonic loop form a large paddle-like loop which easily rotates in any direction, thus predisposing to volvulus. This mechanism may not be responsible for the initial episode, but following the creation of these adhesive bands their presence may account for the unusually high incidence of recurrence. (4) Diet: A coarse, rough diet, common in European areas where there is a high incidence of this disease, is thought to be a factor in the etiology.

## CLINICAL MANIFESTATIONS

The diagnosis of this disease, if kept in mind, should not be difficult. There are the usual signs of obstruction of the bowel, with the following additional characteristics: There is a history of recurrent attacks of pain in 50 per cent of the cases. This pain is noted especially in the right flank and radiates to the right shoulder. The onset of the pain is usually sudden, severe and often colicky. There is tenderness on pressure. Vomiting is noted early whereas when the sigmoid is involved vomiting is late. The abdomen is distended and may present violent peristaltic movements. Tenderness on pressure is one of the most constant and important indications of the disease although it is also distinguished by its acute onset, tympanitic distention of the abdomen and colic without fever. The pulse, temperature and leukocyte count are usually increased although they may not be affected for a considerable time.

## TREATMENT

Conservative measures appear to be little more than palliative in the management of volvulus of the large bowel. In this problem of altered physiology due to a mechanical derangement, the definitive treatment is, as a general rule, surgical intervention. With volvulus of the colon there is not only a closed loop obstruction of the large bowel proximal to the volvulus, but also the twisted segment itself is a closed loop. There is therefore a double closed loop obstruction. Cecostomy or proximal colostomy, as employed for other types of obstruction of the large bowel, has been recommended as treatment for the volvulus of the colon. These operations are illogical and contraindicated. Although such procedures will decompress the colon proximal to the volvulus, they cannot prevent eventual strangulation and perforation of the twisted loop of bowel. On this point rests the importance of making an accurate diagnosis, for although a proximal decompression operation is life saving for other types of colonic obstruction, it is a fatal error to rely on this procedure to relieve the obstruction resulting from torsion of the colonic loop. Volvulus of the transverse colon is best treated by surgery. Although some authors have reduced the volvulus with enemas, there is no assurance that the bowel so reduced is viable. The signs of strangulation are particularly unreliable in patients in the older age group. In addition, there is a real danger of perforating the bowel at the site of the torsion. We believe that non-

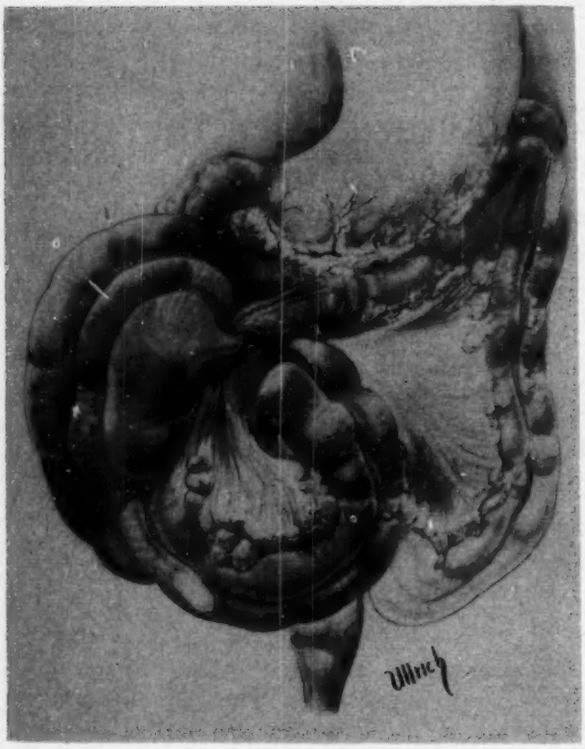

FIG. 1. This shows the relative position of the volvulus prior to reduction.

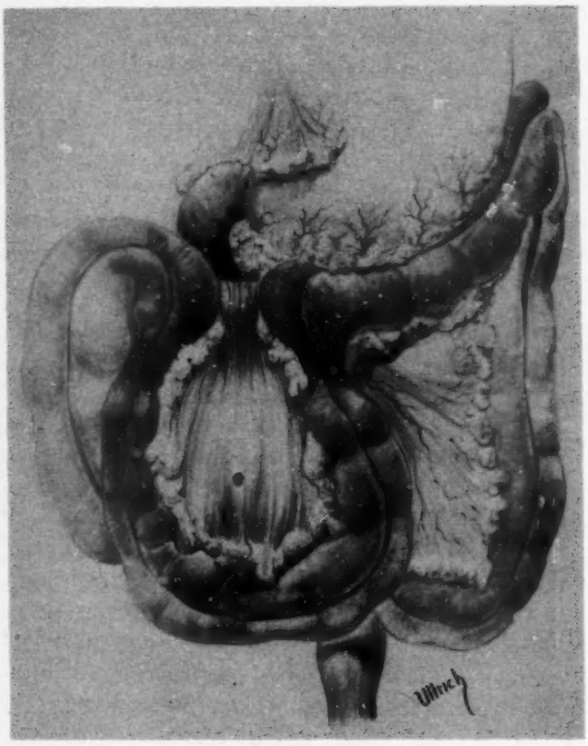

FIG. 2. The volvulus of the transverse colon after being untwisted.

operative treatment is hazardous. The operative approach is therefore the logical one.

There is high incidence of recurrence of the volvulus after fixation of the transverse mesocolon as well as after simple reduction. Because with each recurrence there is a high risk of gangrene and peritonitis, more radical surgery including resection of the transverse colon is often recommended. However, immediate resection and anastomosis are dangerous in the presence of obstruction. The time and manner of resection is determined by the stage to which the pathologic process has progressed. If the circulation of the bowel has not been impaired, the transverse colon is untwisted and replaced in the abdomen. The patient is then adequately prepared for definitive surgery at least two weeks later when the edema has subsided and the bowel has sufficiently recovered its tone and function. Resection with primary anastomosis is then performed. Too long an interval should not be allowed to pass before performing definitive surgery lest volvulus recur.

If at the time of celiotomy the viability of the intestines is questionable, the loop of bowel should be exteriorized. Should the loop prove to be devitalized, it is excised, creating a double barrel colostomy.

In the case reported herein resection was not considered advisable because the bowel contents had not been properly sterilized. (Figs. 1 and 2.) Moreover, resection was not considered imperative because the bowel was viable. A method of fixation of the redundant loop of bowel to the anterior abdominal wall was used. (Figs. 3 and 4.)

This method of transabdominal fixation is a new approach to the problem of volvulus. It has proved highly successful in this case, the patient being symptom-free after two years.

This method is worthy of consideration, for if good results are obtained in subsequent cases its use will save the patient from undergoing further more dangerous operative procedures.

## CASE REPORT

A twenty-nine year old woman was admitted to the Quincy City Hospital on December 15, 1954, with a complaint of severe pain in the right side of the abdomen which was accompanied with nausea and vomiting of eight hours' duration. She had had similar pain three weeks previously, but the pain had subsided after two hours without any medication. Her bowel movements had been regular until the day of admission when she did not move

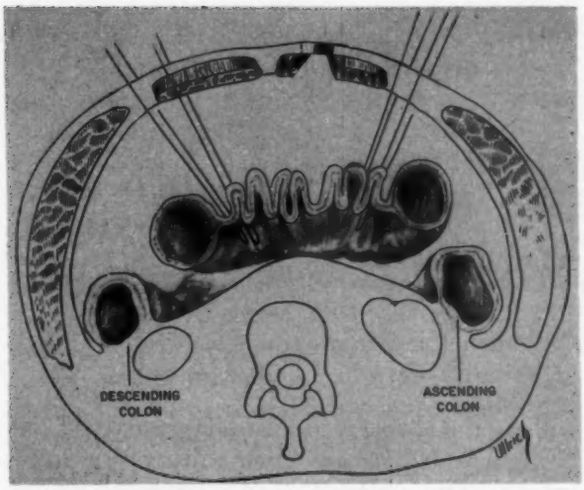


FIG. 3. A cross section illustrating the position in which the sutures were placed in the mesentery of the colon on each side. The sutures were brought out through the abdominal wall from the inside with straight needles.

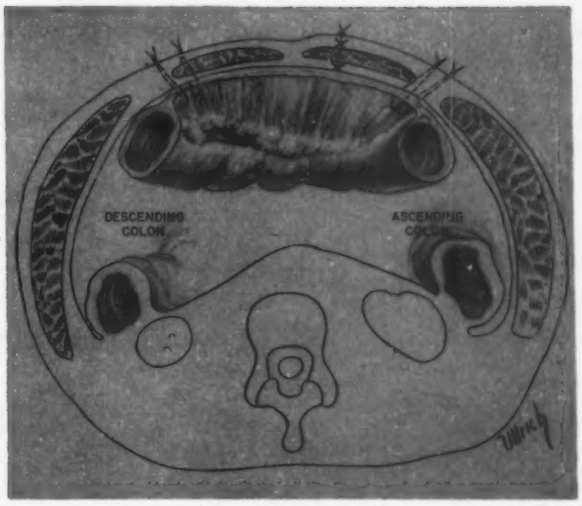


FIG. 4. A cross section illustrating the final position in which the loop of redundant colon was fixed to the anterior abdominal wall by through and through sutures.

her bowels. She had had no previous abdominal operations.

Pertinent physical findings were as follows: The patient's temperature was 98°F., pulse 80/min., and blood pressure 124 systolic, 74 diastolic. The abdomen was not distended but there was muscular rigidity at the right side. Tenderness was elicited at the right lower quadrant and there was a firm, round palpable mass approximately medial to McBurney's point. This mass measured approximately 6 cm. in diameter. It was thought that the mass was a suppurating appendix around which edematous omentum was wrapped. The mass, however, was slightly cephalad and medial to where an appendix would be expected to lie.

Laboratory data were as follows: hemoglobin 12.2 gm. %, white blood count 17,000 per cu. mm., differential count: basophils 1, stab forms 1, segmented neutrophils 80, lymphocytes 15 and monocytes 2.

A diagnosis of acute appendicitis was made and the patient was prepared for surgery. The operative finding was volvulus involving the right half of the transverse colon. The mesocolon was markedly redundant. The right half of the colon was rotated 360 degrees in an anticlockwise direction (Fig. 1.) The twist in the colon was corrected. (Fig. 2.) Fixation of the transverse mesocolon to both sides of the abdominal wall was accomplished. Two long strands of No. 00 chromic catgut sutures were fixed in the mesocolon close to the colon on each side of the colonic loop. (Fig. 3.) The sutures were threaded onto straight needles and brought out through all the layers of the abdominal wall. The sutures were then tied over the skin outside the anterior abdominal wall. (Fig. 4.) The right side of the loop was fixed in the right lumbar region and the left side of the loop was fixed to the abdominal wall to the left of the umbilicus.

The patient tolerated the operation well. The postoperative course was uneventful. The patient was discharged as recovered, on the eighth postoperative day. On follow-up two years later she stated that she had been entirely symptom-free since the operation.

## SUMMARY

1. The authors have presented an outline of clinical manifestations of volvulus of the transverse colon prepared from a review of the literature.

2. A case of volvulus of the transverse colon has been reported and a method of surgical correction and fixation to the anterior abdominal wall has been described.

3. In cases in which the bowel was not sterilized prior to surgery but in which the bowel is viable, this method of correcting and fixing the redundant loop to the anterior abdominal wall by through and through sutures should prove useful. It is hoped that this method of fixation will save the patient from subsequent and more dangerous operative procedures, and well may offer a more permanent cure than previous methods described.

# Acute Obstruction of the Left Colon

## WITH SPECIAL REFERENCE TO THE USE OF A LEFT TRANSVERSE COLOSTOMY

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A GENERAL review of the treatment and end results in malignancies of the colon and rectum over the past forty years shows an increasingly aggressive attack with better results. More tumors are being resected, fewer palliative procedures are necessary, and age no longer seems to be a contraindication for surgery. Surgery performed in two stages has been largely replaced by primary resection and anastomosis not only in the right but also in the left colon. The patterns of cancer spread in the distal half of the colon have been studied more thoroughly and proper emphasis has been placed on wider resections of the primary tumor and node-bearing tissue. The many factors which have contributed to surgical progress in general are well known [*1–5*].

In spite of all the gains made in the elective treatment of cancer of the colon, the mortality rate for patients in whom acute obstruction develops remains high. It is the purpose of this paper to point out the frequency and high mortality rate associated with obstruction of the distal colon and to illustrate how a colostomy placed in the left transverse colon can be helpful in its management.

Although obstruction of the right colon poses problems, the treatment is fairly well standardized. In the left colon, however, obstruction presents a more ominous complication. Obstruction of the left colon which requires proximal decompression occurs four to six times more often than obstruction of the right colon [*6,7,35*]. In 90 per cent of cases it is due to a malignancy. In a collected series of 9,823 cases of cancer of the colon and rectum more than 80 per cent were in the distal half of the colon, including the rectum [*8–30*]. About 30 per cent of all cases of cancer of the colon will produce obstruction, and 5 per cent will be unheralded by any premonitory symptoms [*32–35*]. The majority of these tumors will be found in the descending colon, sigmoid and upper rectum.

In addition to its frequency, this type of obstruction complicating malignancies in the left colon persistently gives rise to a higher mortality rate. While the mortality for uncomplicated, elective resection of cancer of the left colon is about 3 per cent, this figure increases to approximately 25 per cent when the factor of acute obstruction is added [*1,2,12,36–39*]. Furthermore, there is evidence to show that the five-year survival rates in patients with carcinoma of the left colon which obstructs are much lower than in those with carcinoma of the left colon which does not obstruct. Several different, but related, features are present in the left colon obstructed with a malignancy which probably influence and lower the survival rates. These can be briefly listed as: (1) the edema and inflammation present in the bowel wall and cancer; (2) the increased intraluminal pressure and resultant distention; (3) the forceful massaging action of the proximal peristalsis; and (4) the derangement of circulation secondary to a "closed loop" type of obstruction. All of these would seem to be factors favoring the acute spread of tumor metastases [*33*].

Thus, the surgeon is faced with a serious problem when treating an obstruction of the left colon. Such obstructions, occurring in elderly patients, are fatal and require early and effective treatment. The surgeon realizes, too, that not only is the risk greater but also the hospitalization will be lengthened, since in the acute group good judgement and safe surgery dictate that preliminary decompression be done. If a colostomy is performed in the

proximal transverse colon, a third operation will be necessary. The fact that a colostomy placed in the distal transverse colon can be excised very simply along with the cancer or other obstructing lesion at the time of the second elective operation has been very little appreciated.

Surgeons who favor tube cecostomy for handling obstruction of the left colon will protest that a third colostomy-closing procedure is not necessary. Without entering into this argument, it can be said that there is a more general acceptance of transverse colostomy than of cecostomy as the decompressing procedure of choice. [*1,37,40–45*]. There are four advantages of a transverse colostomy which are of particular importance in the treatment of obstructions of the left colon due to cancer: (1) its closer placement to the left colon and its wide stoma allow rapid and complete decompression; (2) it permits better mechanical cleansing of the colon; (3) a measured amount of exploration, which at times is exceedingly valuable, can be done before exteriorizing the loop; and (4) its use in high grade obstruction of the colon is attended by a lower mortality rate than any other procedure.

One disadvantage of the transverse colostomy has been the necessity for closing it. It is true that its closure is not entirely a simple surgical maneuver, and it is not unattended by certain morbidity and mortality rates, although these are low. At the Los Angeles County General Hospital from 1940 to 1951, 180 transverse colostomies were closed, with three deaths [*46*]. Even if there were no deaths, closure still involves another surgical procedure with further physical and financial burden to the patient. Colostomy closure can be eliminated as an added surgical procedure if the left transverse colon, instead of the right, is exteriorized for cancer obstructing the left colon.

The idea of resecting the colostomy along with the primary lesion at the second operation is not unique as an occasional isolated procedure. However, the purposeful placing of a colostomy first to relieve an obstruction and then to be resected along with the source of that obstruction seems to be a worth while and possibly new plan of procedure. A study of the history of colostomy reveals no reference to planned left transverse colostomy. Experience with this procedure first began at the Los Angeles County General Hospital in 1952 when it was performed upon three patients. Since then, the technic has been employed satisfactorily in seven additional patients. In two of these, the etiology of the obstruction was a diverticulitis with perforation.

A good many factors bear consideration when a left transverse colostomy is suggested for use in the treatment of obstruction of the left colon. It must be made clear that such a colostomy should only be used for tumors which lie distal to the splenic flexure. Colostomy resection can then be performed with left hemicolectomy without invading lymphatic channels.

The chief reason for the traditional use of the right transverse colon for decompression has been to keep the left side of the abdomen clean for subsequent surgery. This reason no longer seems valid with the general acceptance of open colon anastomoses and the development of effective antibacterial agents.

Certain routine steps need to be emphasized in the treatment of acute obstruction of the left colon. In addition to careful supportive therapy, the following procedures are requisite in deciding whether or not a left transverse colostomy can be performed: (1) scout film of the abdomen; (2) cleansing enema; (3) sigmoidoscopy; and (4) barium enema. These measures should localize the obstructing lesion. If the tumor is in the descending colon or below, and if decompression cannot be carried out from below using a sigmoidoscope and a rectal tube, then left transverse colostomy is recommended.

The left transverse colon should be brought out through a short, but adequate, transverse incision placed in the left upper quadrant. The left rectus muscle can be avoided completely or partially divided laterally. A vertical incision should be avoided because the bowel decompresses and functions less well through it, and it is a weaker incision. The omentum identifies the transverse colon. The incision need not be large, and frequently no sutures are necessary in a small, well placed incision. A glass rod which extends through the mesocolon under the loop and rests on the abdominal wall supports the exteriorized bowel. The colon can be decompressed immediately by inserting a No. 18 needle attached to suction into the loop. This can be repeated as often as necessary at the time of surgery or on the ward. The colostomy is opened twenty-four to forty-eight

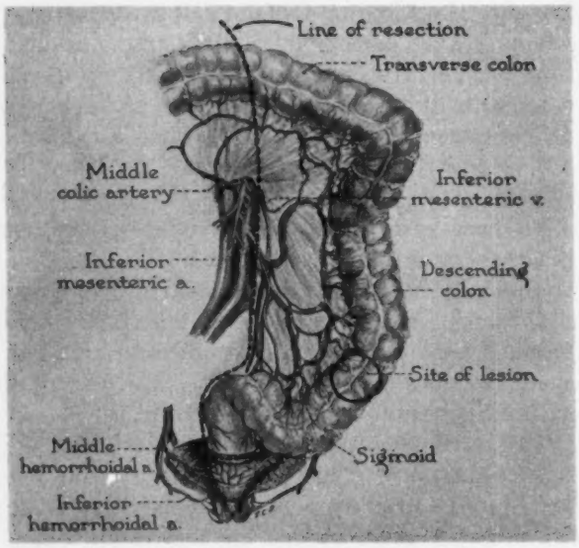


FIG. 1. Anatomy of the left colon; the extent of the resection is indicated by the broken line. Wide resection is advised in order to incorporate the avenues of lymphatic spread which follow the regional vessels.

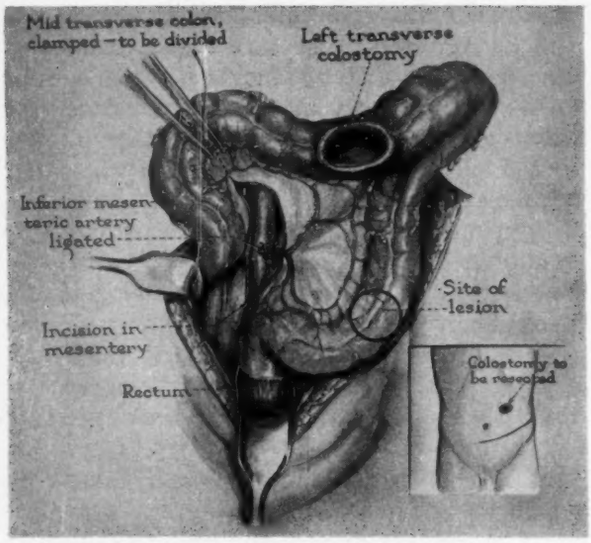


FIG. 2. The inferior mesenteric artery is ligated at its source. The left colon from the mid-transverse colon to the rectum is mobilized, and the colostomy in the distal transverse colon is resected along with the obstructing lesion. Inset indicates the transverse colostomy stoma in the left upper quadrant and below it a satisfactory left lower abdominal incision for resection.

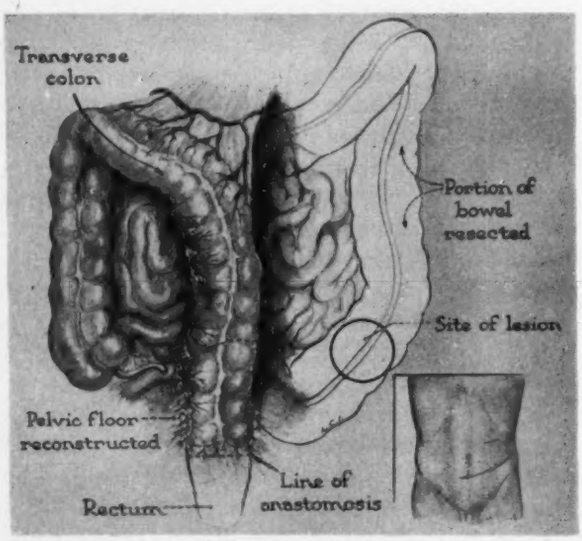


FIG. 3. Drawing outlines the completed resection with the mid-transverse colon anastomosed to the rectum. Inset shows both colostomy and resection incisions now closed.

hours later on the ward by a 2 inch, longitudinal incision through the antemesocolic surface of the loop.

With the colon decompressed and the site and nature of the obstruction ascertained by finger palpation at the time of exteriorization, the colon can be prepared electively with thorough mechanical cleansing and oral and local antibiotic therapy. Colostomy should be avoided if possible, but its use greatly eases the patient with acute or subacute obstruction and facilitates subsequent treatment. The fecal flow is easier to control with the colostomy in the distal, rather than the proximal, transverse colon. Within seven to ten days, depending on the response of the patient, resection can be performed through a left vertical or transverse abdominal incision.

Many comprehensive studies show that one-half to two-thirds of patients with cancer of the left colon will have metastases to the lymph nodes by the time surgery is performed. Furthermore, these metastases are frequently undiscernible to the surgeon, and the size of the lesion gives no correlation to the presence or absence of metastases. Nodal spread first involves the paracolic lymph nodes located along the vascular arches on either side of the lesion. As these become involved, the intermediate nodes in the mesocolon are invaded as they lie between the branches of the colic or sigmoid arteries. The lymphatics closely follow the arterial supply, and thus, the higher the resection in regard to arterial supply, the more lymph nodes are removed. Left hemicolectomy will undoubtedly offer a better prognosis than a lesser procedure [*4,47,48*].

In left colectomy with colostomy resection,

the inferior mesenteric artery and vein are ligated and divided initially. The entire left colon is then mobilized from the mid-transverse colon to the rectum. (Figs. 1 and 2.) The lymph nodes around the aorta and vena cava are cleared from the level of the third portion of the duodenum downward. If the lesion is in the rectosigmoid or even the rectum, it is still possible to bring down the remaining transverse colon to the rectum for anastomosis. (Fig. 3.)


## SUMMARY

1. The seriousness of obstruction of the left colon has been discussed.

2. Left transverse colostomy is advantageous in treating the majority of patients with complete obstruction of the left colon.

3. The colostomy can be resected with the primary tumor and thus allows primary restoration of bowel continuity without the need for a third surgical procedure.

4. The relative proximity of this colostomy to the obstructing lesion allows complete and early decompression.

5. It greatly facilitates the care of the acute and subacute obstruction, and with the knowledge that such a colostomy can be resected at the time of definitive surgery, there need be less tendency on the part of the surgeons to defer its use.

6. Formation of a colostomy in the distal transverse colon does not commit the surgeon to resection, since it functions very well either as a permanent or temporary colostomy.

7. Left transverse colostomy, which can be removed with the primary obstructing tumor at the time of resection, can be combined very reasonably with hemicolectomy for carcinoma of the left colon.


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Thymic tumors may be malignant or presumably benign (lymphomatous type). Myasthenia gravis is usually associated with the malignant tumor; the so-called benign tumors may occasionally recur after resection, as all these growths are potentially malignant. Postoperative x-ray therapy is worth while, especially in the malignant cases. It prevents postoperative recurrences even in the initially "benign" cases. In the absence of myasthenia gravis, prompt excision of any thymic tumor present has frequently prevented the onset of this disease. (*Richard A. Leonardo, M.D.*)

# Cecostomy: Indications and Technic

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CECOSTOMY, properly constructed and properly applied, is an advantageous procedure in the treatment of certain obstructions in the large intestine. In 1939 Rankin [1] pointed out that cecostomy is one of the oldest operations in surgery. The first suggestion of a colostomy was made in 1710 by Littré. However, little was mentioned until 1886 when Pillore performed cecostomy for a rectal neoplasm. In his discussion Rankin sanctions use of cecostomy in obstruction of the left colon. However, at the present time transverse colostomy is preferable in obstructions of the sigmoid or rectosigmoid. In 1952 Albers and Smith [2] made a comparison of cecostomy and transverse colostomy performed in the Los Angeles County General Hospital. Their mortality rate from cecostomy was 56 per cent, and from transverse colostomy 23.5 per cent. Some of the deaths in this series were due to overlooked perforation of the cecum, delay in opening the colostomy, overlooked volvulus of the sigmoid, carcinoma of the sigmoid with inadequate decompression and perforated sigmoid diverticulum. These authors prefer exteriorized cecostomy to tube cecostomy and have reached the same conclusions we have, namely, that cecostomy is the procedure of choice in patients with obstructions proximal to the sigmoid colon, and transverse colostomy is the preferred procedure for patients with more distal lesions.

The fact that cecostomy is more easily performed in the desperately ill person and can be more readily performed with local anesthesia, probably is a factor in the unfavorable mortality rates as compared with those of transverse colostomy. The poor-risk patient is subjected to cecostomy more frequently than to transverse colostomy. In 1955 Berry [3] pointed out that complete diversion of the fecal stream with transverse colostomy is not always necessary in colonic surgery. However, he went on to state that transverse colostomy is the procedure of choice in obstructions due to diverticulitis and ruptured neoplastic growth.

Hunt [4] believes that the enormously dilated cecum frequently pushes the transverse colon up under the liver, making the transverse colon less accessible. He suggests that it is more desirable to decompress the colon at its most accessible point, the cecum. He does not believe that deficiency of decompression by cecostomy should be a complete contraindication to its use.

It is occasionally found at abdominal operation that one is dealing with a colonic malignancy which is only partially obstructing the colon with a minimal or moderate amount of distention proximal to the lesion, with no marked distention of the proximal colon. In these cases a large tube cecostomy performed at the time of resection and anastomosis, as done in Case 11 reported herein, will allow primary resection. Cecostomy at the same time supplies an escape valve for a proximal colon which is not too involved to warrant a stage resection but is enough involved to need proximal decompression. This permits removal of a malignancy at the first operative procedure, avoiding the necessity for closure of the abdominal wound, performance of a colostomy and a subsequent attempt to remove the carcinoma (which has been given longer to grow) through the previously explored abdomen and a previously made incision. In such instances the cecostomy allows the safe performance of primary resection and anastomosis, thus removing the neoplasm at an earlier date and saving the patient an additional one or two operations.

The use of cecostomy in more proximally placed lesions of the colon allows a more adequate, wide excision of the malignancy. Fixation of the transverse colon by transverse colostomy limits the amount of colon that can be removed in lesions of the descending or

transverse colon or splenic flexure, because a mobile transverse colon allows wider resection. With the point of fixation of the colon in the cecum, lesions in these regions can be removed more widely without limitation due to fixation of a portion of the colon.

Since cecostomy is being suggested for more proximally placed lesions, it follows that the cecostomy will function better in these lesions because the content of the colon is more liquid in direct ratio to its proximity to the cecum.

The technic of performing a cecostomy is important. In reviewing articles on the subject of cecostomy, almost without exception the use of a de Pezzer catheter or a small tube has been described. Use of small catheter and small tube cecostomies should be discouraged. This portion of the procedure is probably one of the main reasons that cecostomy has fallen into disrepute. A cecostomy formed with a large tube adequately placed (as will be described herein) will decompress, not completely, but adequately, the proximal lesions of the colon.

After the peritoneum has been opened, the cecum is frequently found to be quite large and dilated and difficult to exteriorize through a small incision. A needle puncture allowing gas to escape will result in easier delivery of the cecum through the wound. The point of needle puncture can be clamped or sutured. Clamping is simpler if the needle puncture has been judiciously placed at a point where the cecostomy will eventually be performed. After the cecum is exteriorized and as much gas as possible allowed to escape through the needle puncture, a larger opening can be made. A good indicator as to whether or not gas is escaping through the needle is to connect a 10 cc. syringe to the needle, removing the barrel first and then pouring some water into the syringe. As long as gas escapes, it bubbles through the water. Using a needle without a water indicator makes it difficult to determine whether or not gas is escaping through the needle. An incision is made in the wall of the cecum and one or two large tubes are placed through the opening in the cecum and through the abdominal wound into the intra-abdominal portion of the cecum. A rubber tube 1 inch in diameter, or two ¾ or ½ inch tubes, gives much better drainage than the more frequently used de Pezzer catheter. Care must be taken that these tubes are not too long. They should be just long enough to extend to the level of the inner portion of the abdominal wall. If the tube is long and is allowed to lay in the cecum or the ascending colon, it is more easily obstructed by the bowel wall than if it is just long enough to pass through the thickness of the abdominal wall, thus keeping the cecum open. Tubes of this size are advantageous in that irrigating tubes can be passed inside their lumens and the cecum can be irrigated if necessary.

After the tubes are removed, the cecostomy usually stays open, in contradistinction to the cecostomy associated with a small tube which closes rapidly. This is one disadvantage to large tube cecostomy but is a small price to pay for more adequate decompression and for allowing more free bowel for adequate resection of malignancies in the transverse colon and splenic and hepatic flexures. Actually, at the time of the removal of the tubes the cecum can be dissected free of its attachment to the skin and subcutaneous fat by blunt dissection and a de Martel clamp placed across the lips of the cecum and left in place as a crushing clamp. At the time this clamp falls away as a result of necrosis, the cecum has healed and the skin and subcutaneous fat will heal over it, thus avoiding surgical closure. This was true in Case 11. On the other hand, if surgical closure of the cecostomy is necessary, it is a much less involved procedure than closure of a transverse colostomy. Transverse colostomies must be closed in every case. These large tube cecostomies sometimes do not require surgical closure. By use of the clamp method, even fewer will need surgical closure.

The cecum is opened without complication at the time the cecostomy is performed. Since in most instances the procedure is performed because of complete obstruction of the colon, it seems unnecessary to wait for an additional twenty-four hours to open the cecostomy. The wound and peritoneal cavity can be adequately protected from fecal drainage by vaseline gauze packing about the cecostomy opening. Furthermore, the purse-string suture that is placed around the large tube prevents spillage at the edge of the cecostomy opening for at least twenty-four hours, until the suture begins to pull through the tissues of the wall of the cecum. For these reasons the cecum is safely opened at the time of the procedure rather than waiting until there is a physiologic sealing-off of the wound in the peritoneal cavity.

CASE REPORTS

CASE I. P. B., a sixty-five year old man, was first seen on August 8, 1952, with a large bowel obstruction in the sigmoid. On exploration it could not be determined whether carcinoma was present or an inflammatory process from diverticulitis. In any event, the obstruction was complete and a decompressive procedure seemed indicated. The bowel contained gas and liquid material. It was therefore decided to perform a cecostomy. This was performed through a separate wound, as described heretofore. Subsequent barium enema studies of the colon revealed that the lesion gradually became smaller and there were multiple diverticula in the descending colon and the portion of the sigmoid colon that could be visualized. On one x-ray the mucosal pattern was seen through the strictured area. Knowing that there was still a possibility of malignancy, resection was planned as soon as possible. On September 23rd resection of the sigmoid colon was performed and pathologic examination of the specimen revealed that the entire process was the result of diverticulitis. The cecostomy was kept open in the immediate postoperative course and, soon after the patient's discharge from the hospital, no attempt was made to keep the ostium open. However, after three months the cecostomy wound continued to drain through a small, persistent opening, and on December 30th closure of the cecostomy was performed surgically. This man's postoperative x-rays have revealed a well healed anastomosis. No hernia has developed in the site of the cecostomy repair.

*Comment.* This case demonstrates the value of cecostomy in the face of a markedly dilated large intestine to the point where it was difficult to deliver either the transverse colon or the cecum. It was impossible to deliver the cecum into the wound until it had been decompressed. Furthermore, at the time of subsequent surgery, the colon was well decompressed and the anastomosis was made without hazard. The cecostomy was also of value postoperatively in acting as a vent for the colon while the anastomosis healed. Although it is true that this cecostomy had to be closed surgically, its closure was not nearly as formidable as would have been closure of a transverse colostomy. In patients with an acute, active, progressing inflammatory mass, transverse colostomy is the procedure of choice to decompress the distal colon completely. This patient's mass was obstructing, but less active and responded well to cecostomy.

CASE II. W. L., a sixty-two year old white man, presented himself to an internist with complaints of acute abdominal pain associated with a minimal amount of vomiting of five to six weeks' duration, with increased severity within the past seven days. The patient had been well until approximately four to six weeks before, when on retiring he had experienced a sudden onset of acute generalized abdominal pain unaccompanied with nausea, vomiting or diarrhea. This pain lasted thirty to forty minutes and then abated spontaneously. The patient was symptom-free for two or three days when he again had an abrupt onset of a similar pain which seemed sharpest at the belt line and to the left. This pain was intermittent, lasting fifteen to twenty minutes and disappearing for intervals of two to four hours. These attacks continued irregularly for approximately ten days, during which time the patient continued to work. He took no medication except milk of magnesia, which he took routinely for constipation. During this time his bowel movements were normal and regular. Approximately one month prior to admission, because of continuing pain, he was sent by a former doctor for an upper gastrointestinal series which demonstrated a small hiatal hernia. He was given a diet and medication, from which he obtained mild relief for eight to ten days. However, his condition then become worse than before, and pains were more frequent and more severe. He eventually had to stop work and presented himself to the internist for examination. He had lost 35 pounds in weight over the previous five or six weeks. I first saw this man on December 28, 1954, the day after he had seen the internist.

On examination his pulse was 80, his temperature 98.6, respiration 24 and blood pressure 132/82. He was chronically ill, dehydrated and presented a markedly distended, tympanitic abdomen. There was mild tenderness over the entire abdomen, with maximal tenderness in the left upper quadrant and anterior left flank. An indefinite mass could be palpated in the left upper quadrant. The mass did not move on respiration and was somewhat tender. There was hyperactivity of the bowel sounds, with occasional rushes

Flat plate films of the abdomen and barium enema given the day before admission to the hospital revealed partial obstruction at the splenic flexure by a large mass in the colon at this level.

It was our impression that this man had carcinoma of the splenic flexure, with partial obstruction. After two days of preparation he was taken to the operating room, where it was found that the transverse colon was moderately distended and that there was a large mass in the upper portion of the descending colon almost at the level of the splenic flexure. There was no evidence of metastasis in the abdomen. The tumor was seen to be adherent to the lateral abdominal wall and the lower portion of the diaphragm over an area with a diameter of approximately 2 inches. The tumor was dissected free, removing all the points to which it was attached, and an anastomosis was performed between the transverse and sigmoid colons. This procedure was decided upon because the proximal colon was not as distended as it had been thought to be preoperatively, and we planned to perform a large tube cecostomy. The cecostomy was performed and two large rubber tubes were placed in the cecum.

Postoperatively, the patient's course was satisfactory and he was discharged from the hospital on the twelfth postoperative day, the fourteenth day after admission. Just before he was discharged from the hospital, a de Martel clamp was placed across the lips of the cecum, which were easily dissected away from the skin. By this time the patient was having normal bowel movements.

Later, in my office, this clamp practically fell away due to necrosis, and the cecum was healed. He has a small hernia at the site of the cecostomy at the present time but there are no associated symptoms.

*Comment.* This case represents the value of cecostomy in a lesion which is proximal to the sigmoid and in which resection is performed in the face of moderate distention proximal to the lesion. This case also demonstrates the value of placing a clamp across the lips of the cecum early, before the cecum has closely adhered to the abdominal wall. Healing of the cecum is hastened by this procedure.

## SUMMARY

1. Cecostomy performed by the large tube technic is superior to small tube or catheter cecostomy. The cecum can be opened at the time of surgery. Healing is hastened by the use of a clamp placed on the cecum at the opening.

2. Cecostomy is indicated as a decompressive agent in certain lesions of the proximal colon.

3. Cecostomy is a procedure of choice in debilitated patients who may not tolerate a transverse colostomy.

4. Cecostomy is indicated in patients who are operated upon and found to have a partial obstruction but who are otherwise suitable cases for primary resection.

5. Cecostomy is particularly useful in patients who demonstrate evidence of a large amount of gas and/or fluid in the obstructed colon.

6. Cecostomy is not suggested when there is need for total defunctionalization of the colon. Neither is cecostomy suggested in sigmoidal or more distal obstructions.

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# Clinical and Laboratory Evaluation of a Resin–Plaster of Paris Bandage

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ABOUT four years ago the water-soluble melamine resins became available for use in improving the strength and moisture resistance of the casts made with the usual hard-coated plaster of paris bandages. For nearly three years a bandage has been available comprising a combination of high density plaster of paris, a melamine resin and a catalyst to induce polymerization of the resin after the bandage is wet. The use of melamine resins in a dipping solution was first developed clinically at Walter Reed Army Hospital and extensive early investigations were made by Cobey [2–4]. Results of clinical evaluation have also been reported by Harvey and Lastrapes [5] and in England by Morrison [6] and Maudsley [7,8].

This study on the clinical evaluation of the resin-plaster bandage has been carried out on the Orthopedic Service at Emergency Hospital, Washington, D. C., supplemented by experience in office practice. The results are compared with the use of ordinary plaster of paris bandages. Some of the clinical observations have been correlated with laboratory measurements* designed to determine the physical properties which are of importance in clinical use of the material.

## CLINICAL EXPERIENCE

Our clinical experience involves the use of Melacast† resin-plaster bandage in a comparative study of 302 casts of all types applied over a period of eighteen months. For comparative purposes, we have also kept records at Emergency Hospital on a series of 262 casts made with a widely used plain plaster bandage. Using a controlled series of cases in adults (Table 1) there are recorded the numbers and types of case, the actual average weight of patients in each category and a figure which is proportional to the area of bandage used in making the casts. The average amounts of bandage of the two types used, when corrected in proportion to the average weight of patient in each category (Table 1, columns 4 and 7), give at least an approximate measure of the relative amounts of resin bandage and of plain bandage required for comparable casts of satisfactory strength in the judgment of the operators. Thus, when based on the same average weight of the patient, the amount of plain plaster bandage used compared with resin-plaster bandage varied from 1.6 to 2.5 times as much, with an average use of two times that of the resin bandage. These figures are, of course, only approximate and do not represent the maximum possible reduction in bandage requirement which might be obtained after considerable experience in using the new material.

Neither operator nor patient showed any evidence of excessive skin irritation due to either type of material. However, we have recorded the incidence of complaints of itching under the casts. In the case of plain plaster casts the incidence was 6.11 per cent as compared to 6.04 per cent with the resin-plaster

* Laboratory tests were made through the cooperation of American Cyanamid Co., Surgical Products Division, Danbury, Connecticut.

† Trademark.

TABLE 1

| Type of Cast | Resin-Plaster Bandage | | | Plain Plaster Bandage | | |
|---|---|---|---|---|---|---|
| | No. of Cases | Actual Average Weight of Patient | Corrected Relative Amount of Bandage | No. of Cases | Actual Average Weight of Patient | Corrected Relative Amount of Bandage |
| Shoulder spica | 3 | 178.0 | 21.0 | 5 | 161.5 | 45.0 |
| Short arm | 10 | 163.1 | 1.7 | 46 | 153.4 | 4.2 |
| Velpeau | 1 | 120.0 | 9.0 | 5 | 130.0 | 20.3 |
| Body jacket | 44 | 161.2 | 17.3 | 14 | 144.2 | 27.8 |
| Hip spica | 4 | 125.0 | 24.6 | 15 | 142.7 | 54.5 |
| Long leg | 43 | 162.4 | 13.3 | 99 | 156.4 | 21.3 |
| Boot | 39 | 155.8 | 7.2 | 54 | 140.2 | 11.9 |

casts, an insignificant difference. The patients who have worn both types of cast comment on the relative lightness of the resin cast when it is properly applied.

We advocate conservative treatment not only in cases of severe, acute back strain but also initially in those patients presenting clinical evidence of a protruded intravertebral disc. Such patients have responded well when treated early by the application of a plaster jacket. To date we have applied a total of forty-four resin-plaster body jackets. The new cast is easier to apply because the bandage does not telescope and the jacket is also light in weight, giving added comfort to the patient. In addition, perspiration and sponge bathing cause no softening of the jacket. We have had a special 8 inch bandage prepared for this purpose; such bandages are now generally available.

In our office practice we treated a series of fifty-two cases of clubfoot and metatarsus adductus in which eighteen resin and thirty-four plain casts were applied. The resin cast appeared to be ideal, as wetting and banging did not deteriorate it.

When windows were made in casts for dressing, it was noted that the resin cast did not soften as did the plain casts and it was not necessary to change the casts as often, resulting in less hospital cost to the patient. This is an important item when one considers that cases of wound drainage are often prolonged and may call for frequent changes of plaster when the ordinary plaster is used. The new plaster has an added advantage in that it does not set extremely fast, and thus lends itself better to molding around a joint or the body.

## RESULTS OF LABORATORY TESTS

The effect of the resin appears to be mainly twofold: (1) to form a strong bond between the particles of plaster and between plaster and gauze backing and (2) through polymerization to protect the gypsum crystal mass against subsequent disintegrating action of moisture. In a plain plaster of paris cast there is very weak bonding between plaster and gauze backing so that the gauze contributes little to the rigidity of the cast, as may readily be seen in crushing a plaster bandage ring on a strength-testing machine where the curve of force versus deformation can be shown to exhibit a stepwise relationship, indicative of breaking more or less layer by layer instead of as a structural unit, with initial deformation occurring after application of a relatively small force. Figure 1 shows the results of crushing tests on a plain plaster ring and a resin-plaster ring. The curves of force versus deformation show the stepwise crumbling of the plaster cast as compared to the sharp break with the resin cast and the much higher breaking strength of the latter. Theoretically at least, once a cast has undergone a permanent deformation, even if it has not broken through, it has failed in its function of immobilizing the patient, and especially the slow attrition of a cast layer by layer through relatively small localized forces eventually leads to complete breakdown of a plain cast. Particularly it is true that with repeated stress a plain cast shows eventual loss of rigidity and very little resilience as compared to the resin cast which far better resists repeated stress of a much higher value. When a properly formed cast does fail, it breaks more or less sharply as

a unit instead of gradually crumbling to the point where it has lost its rigidity. While, as a practical matter, it may not be necessary for a cast to be absolutely rigid, a cast which much

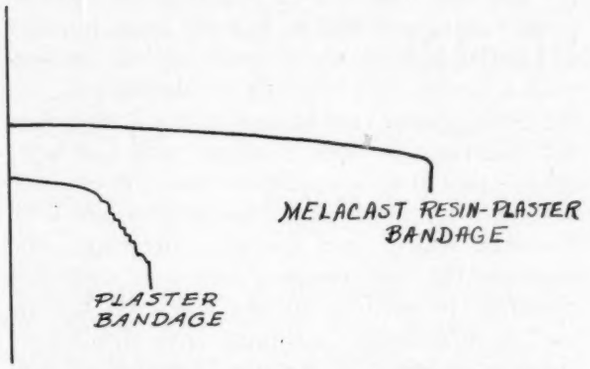


FIG. 1. Results of crushing tests on a plain plaster ring and a resin-plaster ring. Initial deformation on plain plaster cast after application of a relatively small force and further crumbling in a stepwise fashion as opposed to the resin-plaster which requires greater force with breakage occurring suddenly at a higher level.

less readily loses its rigidity would seem to offer an additional factor of safety. Figure 2 shows the effect of repeated stress in breaking down a plaster ring, illustrating lack of rigidity or resilience and the progressively greater deformation as compared to similar results of tests on a resin-plaster ring. These tests were made under conditions of humidity widely met with in practice where the moisture content of the cast is the result of the combined contributions of moisture from the skin and from the atmosphere. They were made by subjecting uniform rings to repeated stress of the amounts indicated, turning the ring to a different position with each successive application of stress. The progressive breakdown of the plaster ring is evident with final complete breakdown after five applications of a force of 17 pounds. With the resin cast, however, the deformation is much less in spite of a repeatedly applied stress three times as great, and final breakdown occurred more or less sharply at over three times the stress.

Figure 3 shows the results of similar repeated application of stress on a plaster ring weighing over twice as much as a similar resin-plaster ring. Here again the progressive breakdown of the plaster ring, with increasing deformation, is evident with final complete breakdown at somewhat less than a stress of 35 pounds repeated ten times. In the resin-plaster cast, the application of 35 pounds could be repeated almost indefinitely without breakdown of the cast, and the force to break the cast was still almost twice the value at which the plaster cast

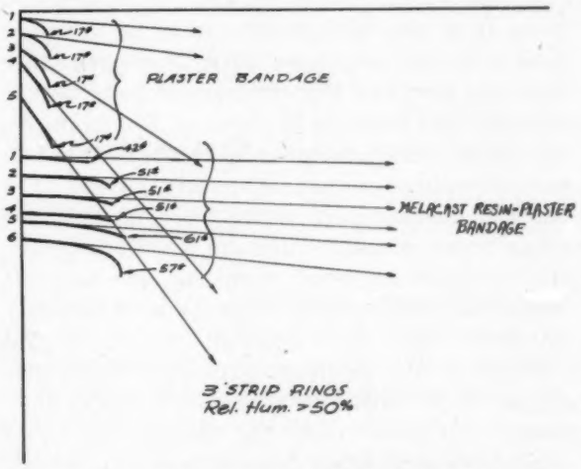


FIG. 2. Chart shows how resin-impregnated plaster sustained stress strain three times greater than ordinary plaster.

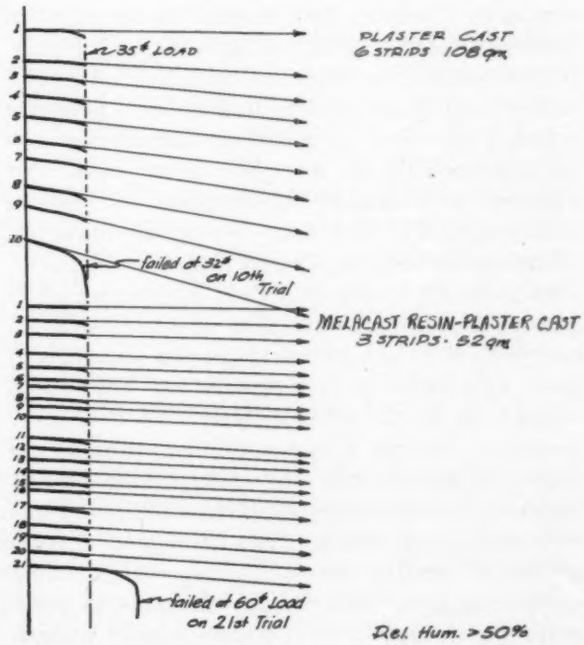
PLASTER CAST
6 STRIPS 108 gm
35# LOAD
failed at 32# on 10th Trial
MELACAST RESIN-PLASTER CAST
3 STRIPS · 52 gm
failed at 60# Load on 21st Trial
Rel. Hum. >50%

FIG. 3. Note how resin-plaster with one-half weight of ordinary plaster sustained stress of 35 pounds indefinitely, whereas ordinary plaster crumbled after ten applications of similar stress. The necessary force to crumble resin-plaster ring was almost double that required to effect deformation of ordinary plaster.

completely collapsed. These results show the tremendously increased factor of safety in the resin-plaster cast in which, under practical conditions of use, the resin cast resisted re-

peated stress without appreciable deformation. Even at half the weight of a plain cast it still required almost twice the stress to collapse.

With reference to the effect of moisture on a cast, one must consider not only what happens when it is wet with water, urine or drainage from a wound but also what effect moisture from the skin and the atmosphere have on the strength and firmness of the cast. For example, laboratory measurements have shown that in an atmosphere of approximately 50 per cent relative humidity at 70°F., an arm cast can retain twice as much moisture when left on the arm as when removed from the arm and left free in the atmosphere. Thus, at least in many instances and especially in warm, humid weather, actual practice involves a moist cast and not a dry one. It is particularly under such moist conditions that the resin-plaster cast exhibits its greatest advantage over a plain cast.

Some operators believe that they can use a relatively thin, plain plaster cast and, from the standpoint of resisting a bending or torsional strain as a whole, that a large diameter, thin tube is a relatively strong structure. However, it can readily be observed that the margin of safety against crumbling due to local pressure is relatively very poor with a thin plaster cast as compared with a resin-plaster cast. For example, this is easily demonstrated by making a thin cylindric cast 4 or 5 inches in diameter, about 20 inches long and of uniform thickness, first from one 6 inch by 5 yard bandage of plain plaster and second, another similar cast from one 6 inch by 5 yard resin-plaster bandage to give cylinders of approximately the same weight. With the plain plaster cylinder, after complete drying, it is very easy to push the finger or thumb into the cast; this is almost impossible with the resin-plaster cylinder. Thus with thin, plain plaster casts there is no margin of safety against crumbling due to pounding or thumping or other types of localized pressure. Furthermore, in a warm, humid atmosphere the thin plaster cast has almost no rigidity and cracks with the slightest pressure.

## SUMMARY AND CONCLUSIONS

Our clinical experience has brought out the following points: (1) the resin-plaster cast runs less chance of being broken or cracked through a fall or other misadvanture because of its added strength; (2) the new cast is ideal for body jackets particularly in patients with severe, acute back strain or in the conservative management of cases of protruded intravertebral disc where the jacket is applied in flexion; (3) the new cast can be made safely light in weight using one-half or less the usual number of bandages, and the patient can be washed with a damp cloth or given an alcohol rub; (4) the resin-plaster cast is easy to apply and does not telescope as does a coarse, stiff bandage; (5) in cases in which windows must be made in the casts for moist dressings or in cases with drainage which need frequent dressings, the resin-plaster cast remains firm and does not macerate or soften; (6) the new cast can be used to advantage on infants with clubfeet or metatarsus adductus because it stands up well under moisture or wetting and the constant banging or thumping of the plaster boot which with an ordinary cast results in softening at the heel or posterior aspect of the sole; and (7) because of its greater strength and hardness the new cast may be more difficult to remove but this is of little consequence compared to the advantages it offers.

Laboratory tests demonstrate (1) the much greater strength and resistance to repeated stress of the resin bandage, especially under moist conditions normally occurring in practice or when wet with water, urine or wound exudate; (2) the bonding of resin, plaster and gauze into a structural unit as compared to the weakly bonded plain plaster cast; and (3) the much greater firmness and resistance to crumbling of the resin-plaster casts and the resultant greater margin of safety with thin casts.

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# Pilonidal Sinus

## A METHOD OF TREATMENT BY PRIMARY CLOSURE

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ALTHOUGH the acquired nature of pilonidal disease is becoming more generally accepted [*1*], many of the principles of operative management remain controversial. Suggested modes of surgical therapy have varied from simple epilation to wide excision *en bloc*. The latter procedure has been justly condemned as applying the philosophy of cancer surgery to a non-malignant process. In the practical sphere, most surgeons appear to agree that the extent of the excision is dictated by the findings at operation and that as little normal tissue should be removed as is consistent with ablation of the chronically infected granulation tissue. Following excision the wound may be treated by the open, semi-open (marsupialization) or closed methods.

With the open method, the defect is packed and permitted to heal by secondary intention. The period of hospitalization is brief, early ambulation is readily accomplished, postoperative discomfort is usually slight and the economic loss to the patient is minimal. On the other hand, the over-all healing time is lengthy, dressing changes are tedious and the patient is left with a cicatrix which is frequently uncomfortable and occasionally unstable.

If successful, treatment by primary closure results in an ideal wound with a small cicatrix which is rarely the source of discomfort. However, hospitalization is prolonged, economic loss is increased and early ambulation is impossible. The requisite prone position and dietary restrictions are unpleasant for the patient, and postoperative discomfort appears common. The presence of either absorable or non-absorbable suture material in the potentially contaminated wound produces an incision which is often erythematous and sometimes frankly suppurative.

Partaking partially of the advantages and disadvantages of both methods, marsupialization has been advocated by some as a rational compromise. While the resultant scar may not be as small as with primary closure, it is less extensive than with the open method. The period of hospitalization is not prolonged and the postoperative management is not unduly meticulous. At best, however, it represents an expedient and not an ideal.

Since the surgical pathology of the débrided and granulating superficial war wound seemed analogous in many respects to that of the pilonidal sinus, the standard method of performing secondary closure of these wounds suggested the application of this procedure to pilonidal surgery. Briefly, the technic employed for secondary closure consisted of excising chronic granulation tissue and coapting the wound edges with vertical mattress sutures of stainless steel wire tied over gauze cylinders. Skin margins were therefore everted and the gauze both prevented cutting by the wire and produced even pressure on the wound.

Although the analysis of Pecora and Cooper [*2*] has indicated that the technical skill of the individual operator is probably of more overall importance in the management of pilonidal disease than is the particular technic employed, the following method is described as a possible resolution of the objectionable features of primary closure while retaining its major advantages. No claim for originality is made.

### TECHNIC

The technic employed is essentially that of primary closure of the surgical defect with vertical mattress sutures of stainless steel wire. Good hemostasis is important and bleeding

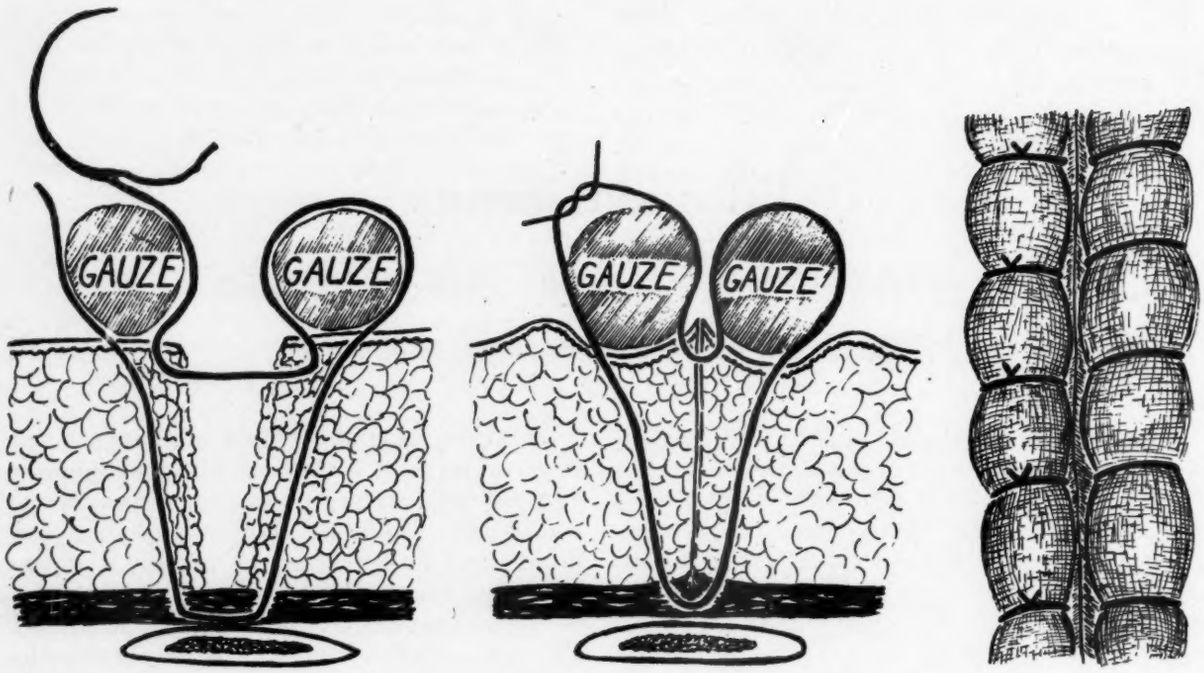


FIG. 1. The diagram illustrates the placement of the wire sutures and the position of the gauze cylinders. Note that the deepest portion of the suture includes fascia.

FIG. 2. As the sutures are tied over the gauze cylinders, the skin margins are everted and dead space is obliterated by the downward and medial pressure of the gauze and the upward pull of the suture.

FIG. 3. Sketch of the appearance of the wound on completion of wound closure.

vessels are gently clamped as the excision progresses. The clamps may be retained during placement of the sutures. Vertical mattress sutures of strong stainless steel wire (No. 28, monofilament) are then placed, using a sufficiently large and sturdy half-curved cutting-edge needle. The wider suture begins approximately 2 cm. from the skin margin, continues inferiorly through fat and finally includes a firm bite of the sacrococcygeal fascia in the depths of the wound. If the defect is deep, the fascial component of the suture may be taken separately. The needle is then continued externally to a point of exit approximately 2 cm. from the contralateral skin margin. The vertical mattress suture is then completed by passing the needle and suture through a 2 to 3 mm. width of skin and subcutaneous fat bordering the defect. (Fig. 1.) The ends of the wire are then clamped. Similar sutures are placed throughout the length of the defect at approximately 1 cm. intervals. Following placement of all sutures, the hemostatic clamps are removed. Usually the compression of vessels will have been sufficient to control bleeding satisfactorily. Should focal hemorrhage recur from larger vessels after removal of the clamps, hemostasis may be secured by fine ligatures of absorbable or non-absorbable material or by electrocoagulation. A cylinder of gauze 1 to 2 cm. in diameter is placed beneath each row of wire sutures, paralleling the wound. Preliminary moistening of the gauze will facilitate its handling. The wire sutures are then tied individually. (Figs. 2 and 3.) If proper tension results, dead space is obliterated by a combination of the downward and medial pressure of the gauze cylinders and the upward pull of the fascial component of the suture. This also aids in maintaining hemostasis by pressure. The skin margins are everted and are usually well coapted if care has been taken in placement of the sutures. A light dressing may then be placed over the wound. Postoperatively the patient may ambulate as soon as desired and the prone position is not necessary. No dietary restrictions are required. Wire sutures are removed on the tenth to twelfth postoperative day, but the patient usually may be discharged much earlier.

## RESULTS

Although a small personal series of ten cases closed primarily and experience with a somewhat larger number similarly treated is insufficient basis for definite conclusions, certain impressions have been gained which appear valid. Three wounds closed with catgut by the multiple-layer technic showed a marked inflammatory reaction. Two wounds closed with both buried catgut and wire mattress sutures exhibited indolent erythema of the wound edges but no reaction about the wire sutures. Five wounds closed with wire mattress sutures alone showed no evidence of inflammatory reaction about the sutures. One wound, however, developed suppuration and was converted to an open wound by early removal of the wires. Unfortunately no long term follow-up of these cases was possible, although one patient seen twelve months after wire mattress suture closure presented a thin, supple scar which was non-tender. In general, inflammatory reaction seemed less and patient comfort greater in those instances when wounds had been closed by wire mattress sutures alone.

## COMMENTS

It is not suggested that the foregoing method supplant the open or semi-open procedures when these are indicated on technical grounds. It is, however, applicable to any defect where primary closure is contemplated. The procedure, of course, is not suited to large defects in which coaptation may be mechanically unfeasible or require undue tension. The presence of acute suppuration is certainly a contraindication to any surgery except incision and drainage. Hemostasis must be satisfactory and obliteration of the dead space must be assured. The virtual omission of buried sutures discourages inflammatory reaction. Should suppuration supervene, the closed wound may be converted to an open one by simple removal of some or all of the sutures, followed by packing. Due to the previous or retained sutures, the extent of the defect which then must granulate is usually smaller than if the open method had been used initially. Full ambulation may be tolerated as early as the first or second postoperative day and the uncomfortable prone position is therefore avoided. Dietary supervision is not needed and early discharge is usually possible. A light dressing favors patient comfort. The method has several disadvantages. If the gauze cylinders become contaminated with feces or other material, their removal will jeopardize the wound closure. In addition, they interfere somewhat with clinical estimation of the wound status. The wire sutures may be a source of discomfort if tied too tightly. Although the patient may be freely ambulatory, it cannot be stated that sitting is comfortable before the fourth or fifth postoperative day. Finally, as to be expected, removal of the wire mattress sutures entails more discomfort than removal of the superficial silk sutures used in the multiple-layer closure. Nevertheless, when contrasted with its advantages, the disadvantages of this method do not appear to constitute a serious problem.

## CONCLUSIONS

A method of primary closure of the defect resulting from excision of a pilonidal cyst has been described. The procedure consists essentially of employing only vertical mattress sutures of stainless steel wire tied over gauze cylinders. Buried suture material is virtually eliminated. The outstanding advantages of the multiple-layer closure are retained, while many of its disadvantages are obviated, particularly in the realm of postoperative care and duration of hospital convalescence.

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# An Unusual Sign in Perforated Peptic Ulcer

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WE have observed an unusual sign of free air in the peritoneal cavity in two patients with perforated peptic ulcer. While testing for rebound tenderness the examiner was able to hear a popping sound as his hand was released from the abdominal wall. Although not as loud, this sound was similar to that heard when a bottle is uncorked.

## CASE REPORTS

CASE I. J. B., a sixty-six year old white man, was a psychiatric patient in a nearby institution. On the day of admission he received his first electroshock treatment. During the procedure he became comatose and was given oxygen. When he recovered consciousness, he complained of severe abdominal pain.

Abdominal examination revealed moderate distention. There was no rigidity. Moderate deep tenderness was present in both upper quadrants. No masses were palpated. Peristaltic sounds were rare. No significant rebound tenderness was noted. While testing for rebound tenderness, a popping sound was heard when the examiner's hand was released from the abdominal wall. This sound resembled that heard when a bottle is uncorked, although it was not as loud. Scout films of the abdomen revealed massive pneumoperitoneum. (Fig. 1.)

At operation a perforated ulcer on the lesser curvature of the stomach was found and repaired. There was no leakage of gastric juice or food into the peritoneal cavity.

CASE II. R. B., a sixty-five year old Negro man, was admitted with a history of abdominal pain beginning approximately twelve hours prior to hospitalization. These pains were located in the epigastrium and were sharp and intermittent. Relief was obtained by taking alka seltzer. Four hours after onset the pains were located periumbilically and had become dull and constant.

Abdominal examination revealed moderate distention. There was generalized tenderness but no rigidity of the abdomen. Peristaltic sounds were absent. The popping sound was sought for by placing the examining hand deeply into the abdomen and releasing it suddenly. A sound was heard similar to that in the first patient. Scout films of the abdomen showed massive pneumoperitoneum and loss of soft tissue detail throughout the entire abdomen. (Fig. 2.)

At operation a gush of air whistled out when the peritoneal cavity was opened. A punched-out ulcer on the anterosuperior aspect of the duodenal bulb was found and repaired. About 1,500 ml. of gastric juice and food were aspirated from the peritoneal cavity.

## COMMENT

Certain conditions are necessary to produce the popping sound. The following features were common in the two cases described: (1) Both patients had large quantities of free air in the peritoneal cavity. The first patient was given oxygen and must have swallowed large amounts. (2) There was no rigidity of the abdominal wall in either patient. The first patient did not have leakage of any gastric content to produce rigidity. The second patient had leakage of approximately 1,500 ml. of gastric content and had frank peritonitis, but there was no abdominal rigidity at the time of examination. (3) Both patients had thin abdominal walls.

FIG. 1.

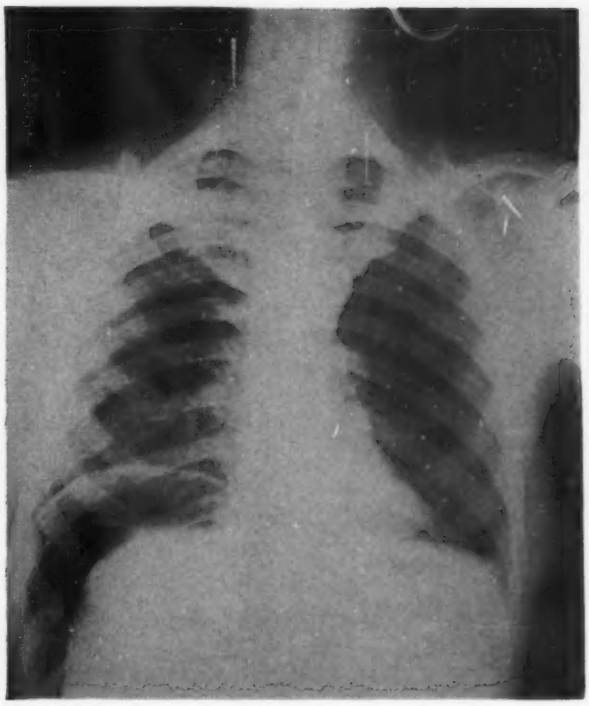

FIG. 2.

The production of sound is dependent on matter which is vibrating. The popping sound in pneumoperitoneum is brought about by vibration of the abdominal wall. This vibration is produced by depressing the abdominal wall and suddenly releasing it. When there is sufficient free air in the peritoneal cavity to separate the abdominal wall from its underlying viscera, the relaxed abdominal wall is able to vibrate with sufficient amplitude and frequency to produce the popping sound. Ordinarily a relaxed abdominal wall without free air in the peritoneal cavity is unable to vibrate with sufficient amplitude to produce the popping sound. In this latter condition the abdominal wall is closely adherent to the underlying viscera, which prevents it from vibrating adequately. Even with free air in the peritoneal cavity, a rigid abdominal wall is unable to vibrate with sufficient amplitude to produce the sound. Under these conditions the rigid abdominal wall cannot be depressed adequately to initiate vibrations of sufficient amplitude.

## CONCLUSION

Free air in the peritoneal cavity may be diagnosed by physical examination when there is obliteration of liver dullness and also when a popping sound is elicited. Obliteration of liver dullness may not be diagnostic in marked pulmonary emphysema and hepatocolic interposition. The popping sign of pneumoperitoneum may be elicited in a patient who has both sufficient free air in the peritoneal cavity and a relaxed abdominal wall.

# A Simplified Method for Operative Cholangiography

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FOR many years at different hospitals operative cholangiography has been a rather awkward procedure and is perhaps for this reason resisted by many surgeons. In previous years we have utilized an x-ray cassette and plate which was placed in a box immediately under the gallbladder area. This had to be inserted and removed from the side, and necessitated lifting drapes and getting the surgeon away from the operating table. Besides the fact that this method is awkward, time-consuming and often difficult, aseptic technic is easily broken. If additional pictures are necessary, the whole procedure may become quite annoying.

Approximately two years ago we had our carpentry shop make a plywood frame to put on the average operating table. Space was allowed for a metal box containing a cassette and large x-ray plate. A cord was attached to the metal box so it could be pulled back. Holes were placed in the side of the plywood frame so that the position of the plate could be readily checked when originally placing it before draping the patient. (Fig. 1.)

A 36 inch ruler is used to push the plate and cassette to the desired point. This measurement is then recorded. The first plate is placed before draping the patient. After this plate is exposed, it is promptly pulled out by the anesthesiologist at the head of the table. At the same time he reloads the metal box and pushes it down the previously ascertained distance. In this manner any number of plates may be taken without disturbing the drapes or the surgeon. The asepsis is at no time compromised, and plates may be removed and reinserted with alacrity. (Figs. 2 and 3.)

The plywood frame utilized can be built in

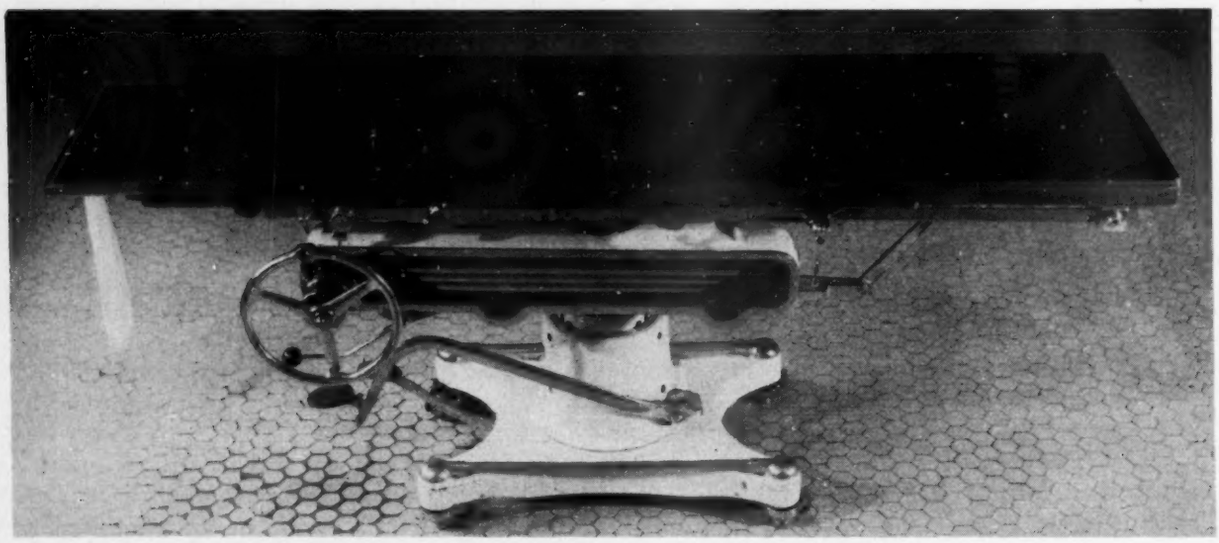

FIG. 1. Plywood frame containing x-ray plate. Note holes on side.

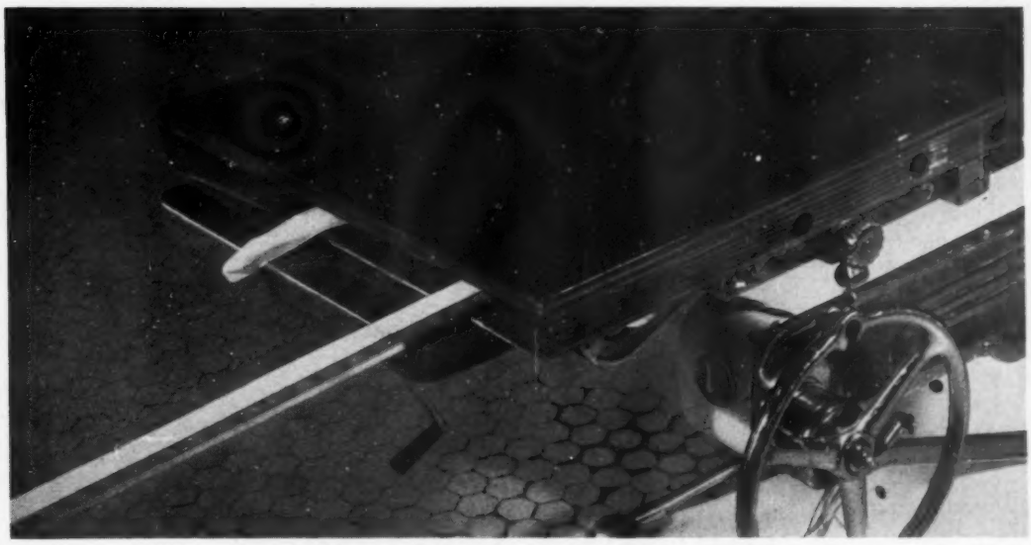

FIG. 2. Ruler utilized to push plate to desired position.

FIG. 3. X-ray plate being pulled out.

any hospital carpentry shop and is inexpensive. We would recommend that it be made firm enough so that the top does not sag under the weight of the patient and impede the progress of the cassette.

This frame has been utilized frequently for well over two years and has been found eminently satisfactory. It is our belief that this simple apparatus may help popularize the more frequent use of operative cholangiography.

# A Method of Cardiofundal Duodenostomy to Overcome Objections to the Billroth I Operation

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INTEREST in gastroduodenostomy for the treatment of gastric and duodenal disease has fluctuated since 1881 when Billroth performed his first successful operation. In the last decade and especially recently this interest has been on the upswing. Some workers have come to praise the procedure while others have condemned it.

In 1881, when Billroth [*1*] reported a successful gastroduodenostomy performed on a forty-two year old emaciated woman for gastric carcinoma, a long stride forward had been taken in gastrointestional surgery. This was the first and the most logical type of reconstruction of gastrointestional continuity after partial gastrectomy. The length of resected greater curvature was 14.5 cm., and of the lesser curvature 10 cm. The greater curvature side of the gastric stump was closed and the end of the duodenum was anastomosed to the lesser curvature side of the stomach. The patient was discharged after a twenty-two-day stay in the hospital and died four months later of diffuse hepatic and omental metastases. Through 1881 four more gastroduodenostomies performed by Billroth were reported.

In 1911 Shoemaker [*2*] modified the procedure to allow better stomal approximation and a more extensive resection of the stomach.

On January 15, 1885, Billroth performed the prototype of what was later to become known as the Billroth II, essentially a gastrojejunostomy, pylorectomy and closure of the ends of duodenum and stomach. The advent of the Billroth II type of operation and the satisfaction with its results minimized the incentive to overcome the early technical objections to the Billroth I. In 1903 Kocher reported the first great technical advance in gastric surgery, i.e., mobilization of the duodenum. In 1924 Finney stated, "The future great advance in surgery of the stomach will depend largely upon the satisfactory mobilization of the duodenum and stomach." Kocher's maneuver not only facilitated the performance of the Billroth I resection but also made possible anastomosis of the gastric end to the duodenal side, as reported in 1922 by Haberer and supplemented by Finney's experiences.

While we do not agree with all of them, the following are listed as advantages of the Billroth I procedure [*3–7*]: (1) decrease in operating time; (2) decrease in total number of suture lines; (3) decrease in operating accidents such as injury to mid-colic vessels, inadvertent injury to the colon and mesocolon, inadvertent anastomosis of stomach to ileum, postoperative obstruction of jejunal loops; (4) decrease in postoperative complications, i.e., marginal and gastrojejunocolic fistulas; (5) decrease in dumping syndrome; (6) a markedly lower surgical mortality rate; (7) no danger of retrograde filling of a closed duodenal loop; (8) no danger of filling of a partial proximal duodenal

obstruction; and (9) generalized improvement in the nutritional status of the patient postoperatively.

Many workers have shown that fat and nitrogen losses are considerably less following direct anastomosis than they are following anastomosis into the jejunum. Nutrition is better than in the Pólya or Hofmeister gastrectomy and physiologic function more nearly approaches the normal [*8–10*]. Because biliary and pancreatic secretions can act in proper sequence their action is more effective, improving metabolic processes, fat and iron absorption and better secretin activation. It has also been observed that when gastroduodenal continuity is maintained, the very passage of acid into the duodenum causes a phenomenon known as duodenal inhibition to serve as a check on the formation of acid by the stomach [*11–13*].

Why then with so many advantages in its behalf did the Billroth I fall into disfavor?

The objections fell into three fundamental groups: (1) The extent of resection proximally had to be limited too much. This did not satisfy the requirements in instances of carcinoma nor in ulcer when wide antrumectomy with extensive resection of the corpus of the stomach is considered necessary [*14,15*]. (2) There was limited applicability to patients with duodenal ulcer because pathologic changes in the duodenum made it unsuitable for anastomosis. (3) There was a high frequency of postoperative obstruction at the anastomosis and of leakage at the *Jammerecke* ("angle of sorrow") [*16*].

Thus, one notes that the objections are raised not on the basis of physiologic disadvantage but on anatomic limitations and restrictions involving technic.

The seven cases reported herein are presented to contribute additional concepts to the technic of gastroduodenostomy which are aimed at removing the stated objections to the Billroth I.

From these concepts, devised and used by the senior author, a procedure gradually developed which allowed not only as extensive a gastrectomy as might be desired but also a completely adequate resection of the duodenal disease.

In all seven cases the diseased portion was removed and a direct line anastomosis was done.

In Cases I and II the standard Shoemaker-Billroth I technic was used and the resultant complications are described. The first step in the modification of the procedure is described in Case III and repeated in Case IV. In both these cases the modification of technic allowed as extensive a resection of a completely mobilized stomach as was desired, limited only by surgical judgment.

Utilizing this method, a freedom of the proximal stomach stump occurred coincidentally which allowed so generous a mobility that it could be implanted into any portion of the duodenum. Thus, the final step in the evolution of removing the objections to the Billroth I was possible, as described in Case V and repeated in Case VI.

In Case VII (reoperation of the patient in Case II), a second gastroduodenostomy, as modified by us, was performed to correct the complications of the original Shoemaker-Billroth I.

### CASE REPORTS

CASE I. S. K., a sixty-seven year old white woman, was admitted to the hospital on September 14, *1955*, with a history of continuous, dull epigastric pains, unrelated to food intake, associated with anorexia and a weight loss of 4 pounds in the previous two weeks. She had been admitted to another institution for similar complaints eight years previously and was treated medically for acute cholecystitis. Blood counts, chemistries and urinalysis were within normal limits. Gastric analysis was negative for free hydrochloric acid and the total was only 8° in a five-hour specimen. Gastrointestinal series on September 15th (Fig. 1A) revealed a polypoid infiltrating neoplasm involving the aspect of the greater curvature of the antrum of the stomach with suggestive spread of this process through the mesocolon to the adjacent transverse colon. A duodenal diverticulum was also demonstrated. After extensive preoperative preparation exploration was performed on September 28th. A dense band of adhesions extending from the transverse colon was found constricting the stomach at the antrum. Gastrotomy revealed a polypoid growth measuring about 1.5 cm. in diameter. A blind pouch (diverticulum) was noted on the terminal end of the first portion of the duodenum.

The stomach was widely resected and the duodenum was mobilized (Kocher's method) and brought easily and without tension up to the gastric stump. A two-layer Shoemaker-Billroth I completed the procedure.

FIG. 1A. Case 1. Gastrointestinal series done on September 15, 1955, revealing a polypoid infiltrating neoplasm involving the aspect of the greater curvature of the antrum of the stomach. A duodenal diverticulum is also demonstrated.

FIG. 1B. Case 1. X-rays taken on October 6, 1955, showing a partial gastrectomy with a well functioning gastroduodenostomy. There is a walled-off extravasation of barium at the proximal stomal site which did not communicate with the general peritoneal space.

The pathologic report was a benign gastric polyp.

The patient made a good recovery. Feedings were begun on the third postoperative day. On the eighth day she complained of epigastric pain and refused food. She had a low grade temperature and a mass became palpable in the epigastrium. X-rays taken on October 6th (Fig. 1B) showed a partial gastrectomy with a well functioning gastroduodenostomy. These roentgenograms suggested the presence of a localized walled-off extravasation of barium at the proximal stomal site which did not communicate with the general peritoneal space.

The mass, the size of a fist, could be felt in the midline of the abdomen between the xiphoid and the umbilicus. The abdomen remained soft and at no time did examinations suggest a spreading process. The mass became smaller for two weeks, one-half its original size, and then remained static. Her appetite and general condition improved, but inasmuch as the mass persisted, she was re-explored on November 7th.

The abdomen was opened and a thick-walled abscess was found. It was incised and evacuated. The cavity at this time did not communicate with the anastomosis although the inflammatory process completely surrounded it. No attempt was made to disturb the anastomosis. The abdomen was closed without drainage. She made a good recovery and was completely rehabilitated when discharged on December 5, 1955. X-rays taken shortly before discharge show the final result. (Fig. 1C.)

CASE II. S. J., a fifty-three year old white male, was admitted on November 17, 1955, with a history of frequent attacks of severe epigastric pains. These dated back to 1948 with periodic recurrent attacks. In May, 1955, the patient had melena and hematemesis for which he had been hospitalized elsewhere. A routine chest x-ray at that time revealed a suspicious

"spot." He had undergone thoracotomy for empyema of the right chest at two years of age.

At the time of the present admission his blood counts and urinalysis were within normal limits. Sputum examinations for acid-fast bacilli were negative on three occassions. Gastric acidity was high with free hydrochloric acid of 30°; combined acid of 100°; total of 130° in a one-hour specimen. Gastrointestinal series (Fig. 2A) revealed an active duodenal ulceration located either in the postbulbar region or in the apex of the duodenal bulb, more likely the former location. Chest x-ray revealed a suspicious infiltration over the left upper lung field, probably tuberculous in origin but not active.

Exploration was performed on November 23rd. A penetrating duodenal ulcer was found occupying the posterior wall of the distal end of the first portion of the duodenum and adherent to the pancreas. A thickened band of tissue was found running upward from the ulcer area toward the liver and within the duodenohepatic ligament. An 80 per cent gastrectomy was performed. The duodenum was mobilized (Kocher's method) and the first portion of the duodenum was removed to a point beyond the ulcer crater. The bottom of the ulcer crater was not removed from the pancreatic surface. A cuff was formed of the duodenum by dissecting the remaining fixed portion from the pancreas, and gastroduodenostomy of the Shoemaker-Billroth 1 type was performed. The pathologic report was a benign duodenal ulcer.

Postoperative x-rays (Fig. 2B) revealed evidence of a recent subtotal gastrectomy with a well functioning gastroduodenostomy and what appeared to be an early marginal ulceration.

The patient made a good postoperative recovery but ulcer symptoms persisted. He was discharged on December 7, 1955, and was advised to return to the hospital for further surgery (see Case VII).

CASE III. B. P., a twenty-five year old man, was admitted on November 23, 1955, with a history of acute epigastric pain and repeated vomiting of about one week's duration. This admission was one of many previous ones with a similar history of pain in the epigastrium and vomiting. On this admission he was given

FIG. 1C. Case 1. Barium study taken on December 1, 1955. There is complete resolution of the inflammatory process with a well functioning gastroduodenostomy.

routine treatment for pain, a special diet and antibiotics. Blood counts, urinalysis and chemistries were within normal limits. Five days after admission a gastrointestinal series was performed, revealing an active chronic duodenal ulcer and a duodenal diverticulum. (Fig. 3A.) This series was compared with a previous series taken by us on April 6, 1955, and showed no change. A gallbladder series was negative.

Operation was performed on December 7th. In the mid-portion of the first duodenal segment there was a thickened firm callous-like induration which bound the entire first portion of the duodenum to the pancreas. Opposite the induration was a pouch-like diverticulum. The inflammatory induration extended upward into the fold of the duodenohepatic ligament causing a dense strap-like contraction of the ligament.

The approach was begun through the gastrocolic ligament to enter the lesser omental sac and identify the middle colic vessels. The right and left gastroepiploic vessels were tied off and the greater curvature was freed. The

FIG. 2A. Case II. X-rays taken on November 19, 1955, reveal an active duodenal ulcer in the postbulbar region.

FIG. 2B. Case II. Postoperative x-rays show a recent subtotal gastrectomy with a well functioning gastroduodenostomy and an early marginal ulcer.

FIG. 3A. Case III. X-rays reveal an active chronic duodenal ulcer and a duodenal diverticulum.

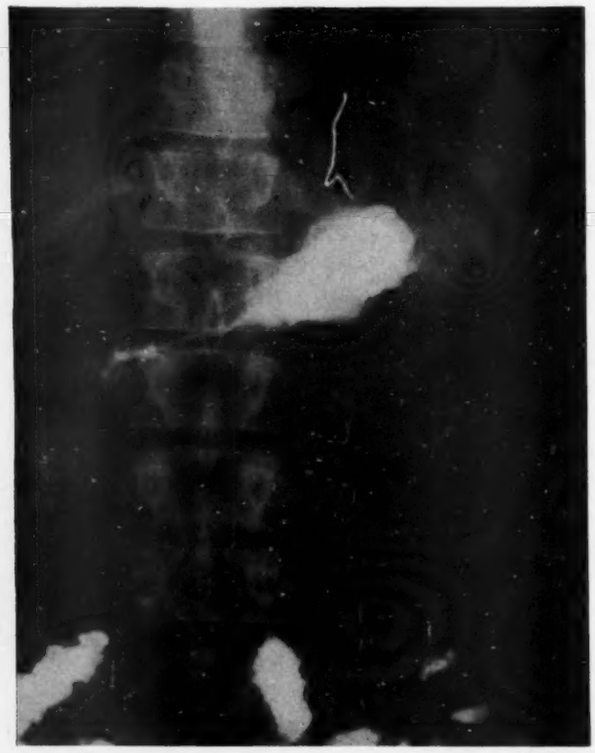

FIG. 3B. Case III. Postoperative study after cardiofundal duodenostomy, well functioning.

right and left gastric vessels were secured and the duodenohepatic and gastrohepatic ligaments cut, thus freeing the lesser curvature.

At this point the procedure was modified. Having in mind the work done on collateral and intramural blood supply of the stomach [*17*], *all* the short gastric vessels of the stomach were cut and ligated and the entire fundus of the stomach was freed to its cardioesophageal juncture. Point B (Fig. 4), up to which the duodenum had to be brought in the usual Billroth I, was now no longer fixed. The fundus could now be extended into a line as A $B_1$. (Fig. 4.) Not only was the previously tethered point B (Fig. 4) now mobilized so that it could be extended to point $B_1$ (Fig. 4) but also it could be swung like a pendulum across to point $B_2$ (Fig. 4) and easily juxtaposed to any portion of the duodenum. It also becomes apparent that a stomach so completely freed made the vagi more accessible.

Bilateral vagotomy was performed and the duodenum was mobilized (Kocher's method). The extent of resection was now only a question of surgical judgment and no longer limited by anatomic restrictions.

The shaded area in Figure 4 indicates the pattern of resection. Approximately 90 per cent of the stomach, including the ulcer-bearing duodenum and diverticulum, was resected. The unshaded area in Figure 4 (A $B_1$) represents the stomach remnant. The line of resection on the remnant opposite A $B_1$ is closed in two layers, leaving a stoma at $B_1$. The anastomosis is easily made as shown in A $B_2$. We have given this procedure the name "cardiofundal-duodenostomy" in keeping with the anatomy involved. It is interesting to note that this procedure converts the "dome" of the fundus of the stomach into an active propelling segment of the new stomach and eliminates its previous "expansion tank" function. Swallowed air and gas are no longer trapped in this "expansion bell" but are quickly and immediately vented through the esophagus. We believe that the so-called "dump syndrome" should be ascribed more properly to the secondary effects of upper gastric dilatation due to trapped gas and air. In the usual gastrectomy, wherein the fundal dome is left intact, the symptoms are manifest so much more acutely when a percentage of the lower segment of the stomach has been removed.

The pathologic report was duodenal ulcer; diverticulum of the duodenum; non-myelinated nerve fibers.

Postoperative x-rays revealed a partial gastrectomy with a well functioning cardiofundal duodenostomy. (Fig. 3B.) The patient was discharged improved on December 20, *1955*.

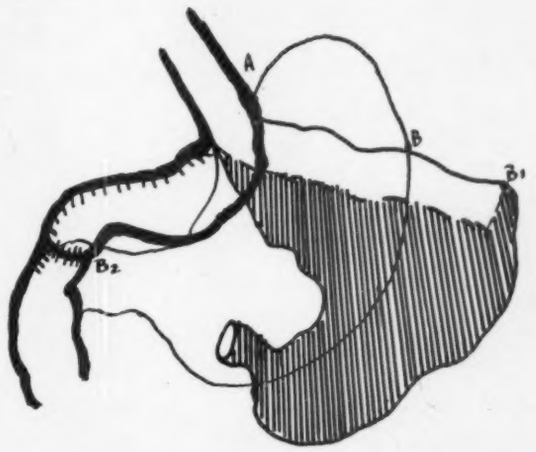


FIG. 4. A diagrammatic representation of the pattern of resection. Curved line A B continuing as a light outline shows the fundus and stomach *in situ*, straight line A $B_1$ the mobilized and extended fundus bounding the stomach remnant. The shaded area is the area of resection. A $B_2$ shows the transported position of the stomach remnant from position A $B_1$. This is shown in heavy outline, the short hatch marks indicating the suture lines.

CASE IV. J. R., a sixty-four year old white man, was admitted on November 25, 1955, with a history of nausea, hematemesis and severe epigastric pains of three days' duration. About two years previously he had had a similar episode, although not quite as severe. Attacks of epigastric pains three to four hours after eating were usually relieved by sodium bicarbonate. Chronicity and periodicity of symptoms marked the two-year history. Blood counts and urinalysis were within normal limits; stool examination revealed 3 plus occult blood. A gastrointestinal series (Fig. 5A) revealed a small pyloric ulcer with associated antral gastritis and duodenitis.

Exploration was performed on December 9th. A penetrating duodenal ulcer was found adherent to the pancreas. The same procedure as described in Case III was followed.

The pathologic report was benign duodenal ulcer; non-myelinated nerve fibers.

Postoperative gastrointestinal series (Fig. 5B) gave evidence of recent subtotal gastrec-

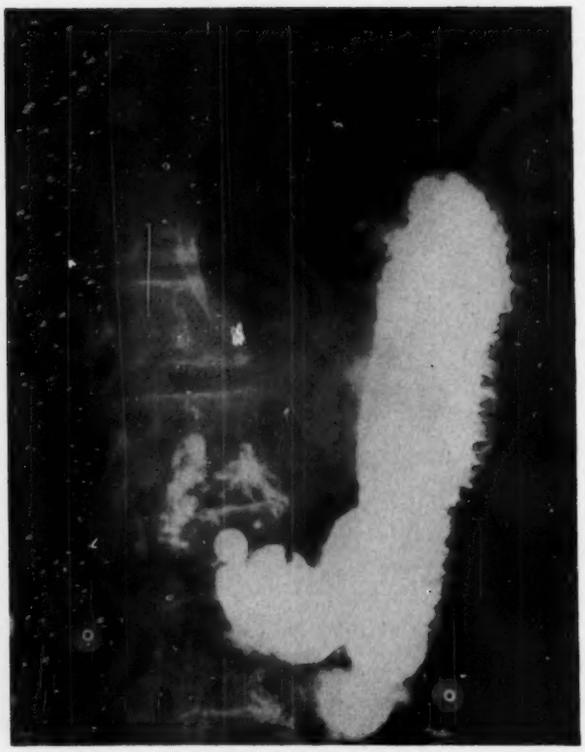

FIG. 5A. Case IV. Gastrointestinal series showing a small pyloric ulcer associated with an antral gastritis and duodenitis.

FIG. 5B. Case IV. Postoperative barium view after gastrectomy and cardiofundal duodenostomy, well functioning.

tomy with a normally functioning cardiofundal duodenostomy. The patient was discharged recovered on December 29, 1955.

CASE V. R. T., a thirty-five year old man, was admitted on December 5, 1955. He had a known duodenal ulcer of three years' standing and had been under strict medical care for two years. For one week previous to admission he had had anorexia and weakness. On the day of admission he had vomited a dark black fluid; that evening some bright red blood was found in the dark fluid vomitus. Stools were black. He was given fluids, transfusions, vitamins K and C and antibiotics. Bleeding stopped and his general condition stabilized. X-rays taken on December 9th revealed a duodenal ulcer with no obstruction. (Fig. 6A.)

Exploration was performed on December 10th. An indurated duodenal ulcer was found on the posterior distal part of the first portion of the duodenum. Essentially the same technic was employed as in Case III except the sequence of steps was changed. The entire greater curvature from the duodenum to the esophagus was freed. This allowed the stomach to be turned upward. This everted view allowed a posterior approach to the left gastric and right gastric vessels. They were secured and the gastrohepatic ligament was cut. The stomach was now completely mobilized. Bilateral vagotomy was performed.

It was at this point that we modified the preparation of the duodenal stoma. The usual preparation of the duodenum as it was peeled away from the pancreas left 20 to 30 per cent of its circumference without a serosa. It was believed all along that an anastomosis without a complete 360 degree serosal approximation must perforce be predisposed to leak, recurrence of ulcer and obstruction. Furthermore, sutures not buried in serosa were but capillary wicks against a denuded pancreas.

Having the advantage of a proximal stomach stump which was so generously mobile, the anastomosis need no longer be made into the first and usually diseased portion of the duodenum. Instead we used the second portion. The ulcer-bearing first portion of the duodenum was therefore completely removed. The stomal opening into the second portion of the duodenum was made elliptic in form (Fig. 7*a*)

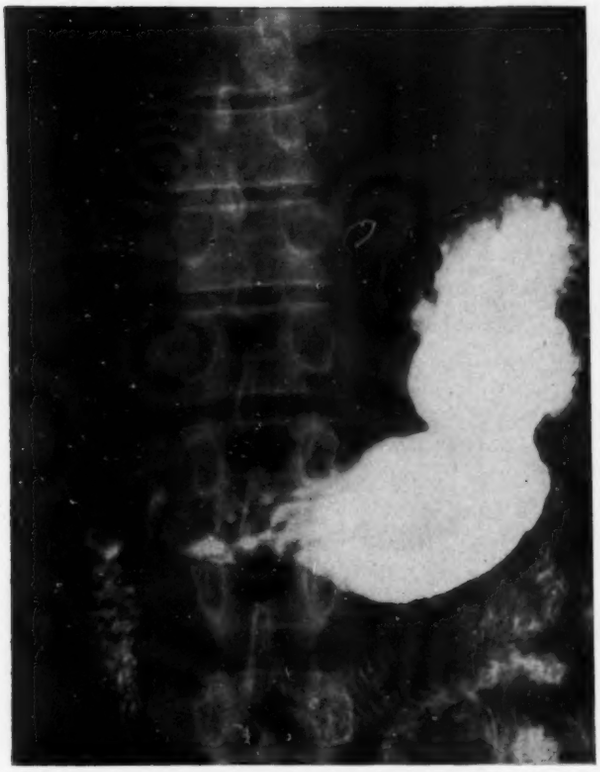

FIG. 6A. Case v. Gastrointestinal series revealing a duodenal ulcer.

FIG. 6B. Case v. Postoperative x-rays showing a subtotal gastrectomy with a well functioning cardiofundal duodenostomy.

by a slit beginning at the anterior border of the stoma downward in the long axis of the descending duodenum. The upper angle of the ellipse thus formed was closed in two layers, mucosal and seromuscular (Fig. 7*b*), from above downward until its elliptic shape became a circular one of the desired stomal size. There is enough "yield" to the side walls of this part of the duodenum to allow a mobile cuff to be formed having a serosal covering completely around it. Such a cuff (Fig. 7*c*) not only insures a serosal covering but also allows the anastomosis to be made without fear of encroachment upon the ampullary opening of the common duct into the duodenum. It eliminates the necessity (as in the Haberer-Finney procedure) of inverting the end of the duodenum which, if resected close to the ampulla, might cause encroachment upon it. It also eliminates the need for a second opening into the duodenum, thus saving considerable time. Furthermore, the anastomosis is completely mobile and not contiguous with pancreatic tissue.

Eighty-five per cent of the completely mobilized and vagotomatized stomach was removed and a cardiofundal duodenostomy was performed. (Fig. 7*d*.)

FIG. 7. (*a*) The angle formed by the first (light outline) and the second (heavy outline) portion of the duodenum. Note the elliptic stoma as described in Case v and repeated in the subsequent cases. (*b*) The upper angle of the elliptic stoma sutured from above downward in two layers to form a stoma of desired size having serosa completely around it. (*c*) Lateral view of (*b*). (*d*) An *in situ* representation of the cardiofundal duodenostomy.

The pathologic report was duodenal ulcer; vagus nerves.

Postoperative x-rays (Fig. 6B) revealed a subtotal gastrectomy with a well functioning gastroduodenostomy. The patient was discharged on December 23, 1955.

FIG. 8A. Case VI. Barium study of the stomach; duodenal ulcer.

FIG. 8B. Case VI. Postoperative views showing partial gastrectomy and well functioning cardiofundal duodenostomy.

CASE VI. C. R., a thirty-eight year old man, was admitted to the hospital on January 2, 1956. He had a known history of ulcers of ten years' duration and had been under a strict medical regimen for one year. Pain was intractable, and more frequent and more intense of late. Gallbladder series were negative; gastrointestinal series revealed a duodenal ulcer. (Fig. 8A.) Routine general examination and laboratory check-up were essentially normal.

On January 3rd laparotomy was performed. An indurated duodenal ulcer and a thickened stomach were found. The ulcer was in the distal first portion of the duodenum on its posterior wall. Vagotomy and gastric resection of 90 per cent of the stomach were performed. Essentially the same procedure was used as described in Case V.

The pathologic report was chronic duodenal ulcer; chronic gastritis; vagus nerves.

Postoperative x-rays revealed a subtotal gastrectomy with a well functioning gastroduodenostomy. (Fig. 8B.) The patient was discharged on January 14, 1956.

CASE VII. S. J., a fifty-three year old white man, was readmitted to the hospital on February 20, 1956, for a marginal ulcer following subtotal gastrectomy. A Billroth I had been performed on November 23, 1955 (Case II). Symptoms were a recurrent pattern of those on his previous admission plus a dump syndrome. X-rays revealed the presence of an ulcer crater at the site of the anastomosis between the duodenum and stomach. (Fig. 9A.) Routine blood count, urinalysis and chemistries were within normal limits. On February 24th exploratory laparotomy was performed with the view of excising the ulcer and revising the anastomosis. Adhesions of stomach to anterior abdominal wall were found and dissected free. As the dissection was carried toward the anastomosis, the ulcer crater was opened and the stoma was found to be involved in a cicatrizing inflammatory process surrounding some silk sutures. There was a ballooning of the duodenum distal to the anastomosis. The latter was freed. The ulcer-bearing stoma, the remainder of the first portion of the duodenum and about 1 inch of distal stomach stump were removed. The opening of the ampulla of Vater was brought into view. All the short gastric vessels were cut to free and straighten the cardiofundal dome of the stomach. The opening into the duodenum was cut on a bias to form an ellipse. The opening of the ampulla was less than ½ inch from the upper angle of the elliptic duodenal opening. The same technic as described in Case V allowed a cuff well away from the ampullary opening to be formed and a cardiofundal duodenostomy having a complete serosa-to-serosa juncture

FIG. 9A. Case VII. A repeat study of Case II, showing partial gastrectomy which was previously performed and the repair by the method of Shoemaker-Billroth I. There is an ulcer crater at the site of anastomosis between the stomach and the duodenum.

FIG. 9B. Case VII. X-ray after reoperation. A cardiofundal duodenostomy is shown functioning well. The stomal ulcer is now absent.

was completed. In this case we made by far our lowest duodenal implant.

The pathologic report was benign chronic marginal ulcer.

Postoperative x-rays revealed that the previously described stomal ulcer was absent; a well functioning gastroduodenostomy stoma was seen. (Fig. 9B.) The patient made a good recovery and was discharged on March 12, 1956.

## CONCLUSION

Seven cases are reported showing the evolution of a modified gastroduodenostomy aimed at removing the objections to and restrictions of the Billroth I. The concepts and thoughts herein submitted are offered as a preliminary report so that additional experiences with them may be contributed in the future.

## ADDENDUM

Since submitting the original manuscript for publication we have performed four additional cardiofundal duodenostomies as described herein. Three operations were performed for duodenal ulcer, and one for a benign gastric ulcer on the lesser curvature. In one of the patients with a duodenal ulcer the duodenal stoma was closed and the fundal stoma was anastomosed to the anterior surface of the second portion of the duodenum (Haberer-Finney) as an end-to-side anastomosis. All four patients made a good postoperative recovery and are doing well.

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*We recommend:*

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# Benign Stenosis of the Bile Ducts

## A REVIEW OF THE LITERATURE

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THE process of ulcerative cholangitis may occur in any portion of the biliary tree; the lesion causing these strictures is the end result of inflammatory changes occurring during the course of cholangitis. Benign fibrous stenosis of the bile ducts has been frequently reported as a cause of biliary obstruction; 80 per cent of these strictures were attributed to some form of surgical trauma. The finding of stenotic areas at the first operation has led me and other investigators to believe that the condition may be the end result of ulcerative cholangitis. Benign strictures of the intrahepatic ducts give additional proof that the lesion may occur primarily, independent of surgical trauma, whether or not the patient has undergone surgery.

Strictures of the biliary tract may be either congenital or acquired. The congenital type is most frequently recognized in infancy and is thought to be a condition that develops *in utero* as a result of transmission of some toxin from the mother to the fetus. A combination of cirrhosis and cholangitis is established and the end result is an obliterative cicatrization of the ducts. This could explain the true congenital strictures found in infants shortly after birth. This same process may occur in fetal life, involving the smaller ducts, and remain dormant, not giving rise to any signs or symptoms until later in adult life. These stenotic areas may be intrahepatic and involve various segments of the intrahepatic radicles. The same process could be initiated in adult life as a result of infection, chemical irritation, virus or trauma, independent of any inheritance. The stenosis which develops insidiously is the end result of either one or a combination of the aforementioned factors. Calculi, which are observed in these stenotic areas, are the result of infection and obstruction and not the causative factor of the stenosis. Strictures resulting from passage or removal of stones are an infrequent finding. When no calculi are found in the common or hepatic ducts, immediate operative cholangiography can be of aid in diagnosing a number of these unexplained cases of obstructive jaundice.

Judd [1] reviewed sixty-four cases of stricture involving the common duct. He was impressed by the fact that the common duct was patent for many months, and in some cases for several years, after cholecystectomy before any sign of stricture developed. It is difficult to attribute these late manifestations to anything that had occurred at the time of cholecystectomy. In some of the cases there was evidence of intermittent obstruction before any operation had been performed. No cause could be found for this when the gallbladder was removed, and since no stones were present in either the gallbladder or the common duct, one must assume that cholangitis was present prior to the operation. In other cases, signs of common duct obstruction occurred soon after cholecystectomy. At the second operation an obliterative process of the entire duct was found, without stones. Diffuse cholangitis is difficult to recognize because of the edema in the ducts and the surrounding tissue, and oftimes the ducts are concealed in the inflammatory mass. Lahey [2] reported a case of complete obliteration of the bile ducts due to an inflammatory process which completely destroyed the mucosa within the common and hepatic ducts, converting the stricture into a fibrous cord without a lumen. Philips and Kilgore [3] reported a case of primary inflammatory stricture of the common bile duct. This was followed by a report of benign fibrotic lesion of the common bile duct by Carter [4]. Sections of the wall of the ducts which were removed showed various stages of

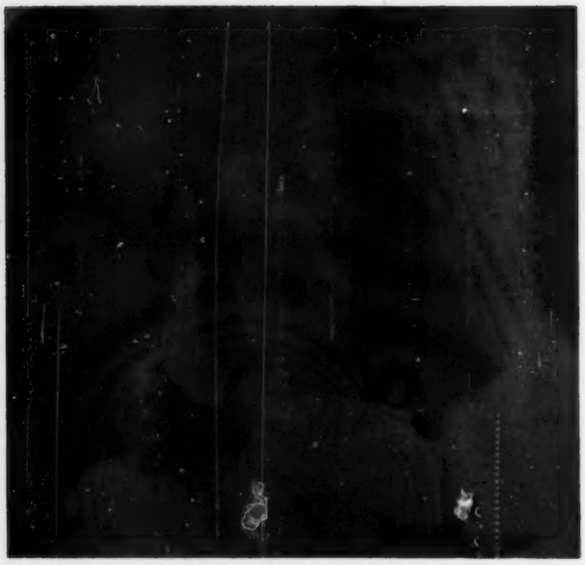

FIG. 1. Case 1. Shows (A) first portion of duodenum suspended by adhesion to (B) common hepatic duct with fistula, revealing barium in the hepatic ducts.

inflammation, i.e., hyperemia, cellular infiltration, necrosis, ulceration and fibrosis. Carter and Gillette [5] published a monograph dealing with fifteen cases of benign strictures involving the intrahepatic bile ducts. These authors verified the cause of obstructive jaundice by the use of operative cholangiography. Many of these cases could have been relegated to the category of biliary cirrhosis before cholangiographic studies were undertaken. Cattell [6] aptly pointed out, in his article on benign strictures of the biliary ducts, that insufficient attention has been directed to the cause of benign obstruction and that at times it was difficult to determine with any degree of accuracy the frequency of these strictures. Many patients died with evidence of obstructive jaundice and the underlying cause remained unexplained. May not many of these patients have had a stenotic lesion produced as a result of obliterative cholangitis?

Within the past year I operated upon two patients with benign fibrous stenosis, in one the common bile duct was involved and in the other, the left intrahepatic duct. The first patient had had a previous cholecystectomy, while in the second patient the stenosis was encountered at the primary operation. In both patients non-calculous gallbladders were revealed and no stones were found in the common duct. The clinical picture and liver studies indicated definite evidence of obstructive jaundice.

## CASE REPORTS

CASE 1. V. W., a thirty-five year old married white woman with two children, had undergone appendectomy at the age of thirteen and cholecystectomy at the age of thirty-one. She stated that six months after the cholecystectomy in 1949, she became jaundiced and when a medical regimen was instituted, the jaundice cleared. The patient had a few attacks of jaundice unaccompanied by any pain and the jaundiced state would clear when she followed a strict diet free of fatty foods. In the latter part of 1952 she was seized with severe epigastric pains which radiated to her back and shoulders, following which she became nauseated and vomited. The jaundice reappeared and was accompanied by bouts of chills and fever. In spite of antibiotics, antispasmodics and diet the pains became more severe and the jaundice increased in intensity. A gastrointestinal series performed by her family physician revealed a fistulous tract between the first portion of the duodenum and the common hepatic duct (Fig. 1), and what the roentgenologist interpreted as a calculus in the common duct. (Figs. 2 and 3.) Physical examination revealed some tenderness in the right upper quadrant of the abdomen. The abdomen was soft; the liver and spleen were not palpably enlarged or tender.

Laboratory findings were as follows: white blood cell count, 17,500 per cu. mm. with 72 segmented and 7 non-segmented cells; hemoglobin, 9.9 gm. per cent; urine, positive for urobilinogen; blood sugar, 104; cholesterol, 410; esters, 180; alkaline phosphatase, 27.2; thymol turbidity, 8; zinc turbidity, 12; icteric index, 81; cephalin flocculation test, ±.

The patient was admitted to the hospital on January 8, 1953, and a high protein-high carbohydrate diet was instituted. She was given synkavite® twice daily, a blood transfusion and vitamins. On January 13, 1953, the patient was taken to the operating room where an immediate operative cholangiogram was performed (Fig. 4), which revealed dilatation of the common hepatic duct, right and left hepatic ducts and intrahepatic radicles. None of the dye entered the common duct, which was a solid fibrous cord extending from the site of the cystic common junction to the sphincter of Oddi. The fibrous cord was opened throughout its length and no channel was found. The first portion of the duodenum was suspended

FIG. 2. Case 1. Shows (A) small rounded shadow, suspected calculus.

FIG. 3. Case 1. Shows (A) barium fleck in common hepatic duct three hours after barium meal.

by an adhesion 1 inch long and ½ inch in diameter, which communicated with the common hepatic duct at the site of the cystic common junction. Apparently the choledochoduodenostomy fistula ran through this adhesive band. After the band was divided a side-to-side choledochoduodenostomy was performed without an obturator. The patient was given nothing by mouth for eleven days postoperatively. She received 3,000 cc. of fluids daily, 1,000 cc. of 5 per cent glucose in water, beminal,® 500 mg. of ascorbic acid, 1,000 cc. of amigen® and 1,000 cc. of 5 per cent glucose in saline. A Levin tube was inserted and Wangensteen suction continued.

Liver tests done on January 26, 1953, revealed the following: cholesterol, 78; esters, 62; icteric index, 38; alkaline phosphatase, 21.5. Follow-up five months later revealed that the choledochoduodenostomy was functioning perfectly. (Figs. 5, 6 and 7.) Liver tests showed: cholesterol, 195; esters, 60; alkaline phosphatase 3.0; icteric index, 1.2. The urine was negative for bile.

*Comment:* The common duct in this case was patent for a few months following cholecystectomy; and it was not until several years later that the signs and symptoms of acute obstructive jaundice manifested themselves. Therefore it is improbable that these late manifestations were due to surgical trauma. Since no stones were found at the primary operation, and since the pathologic examination revealed edema and infiltration of the wall of the gallbladder, it is safe to assume that an infectious process was present in the gallbladder. At the second operation, instead of a suspected calculus in the common duct, I found a complete obliterative process in the duct extending throughout its entire length. Trauma could not produce such an extensive fibrotic condition without the presence of some infectious process within the walls of the duct. It is my contention that the obliterative cholangitis antedated both surgical procedures, and both processes were due to ulcerative cholangitis.

A valuable aid in establishing the presence of the fibrotic state in this case was the immediate operative cholangiogram. The use of this procedure pointed out the exact location and extent of the pathologic process and helped to determine the course of the surgical procedure;

FIG. 4. Case 1. Immediate operative cholangiogram; dilated common hepatic duct (A), right (B) and left (C) hepatic ducts and dilated intrahepatic ducts. There was no dye in the common duct.

FIG. 5. Case 1. Film taken approximately five months after surgery shows hepatic ducts of normal size (A). Film was taken half an hour after barium meal.

a cholodochoduodenostomy anastomosis was performed.

CASE II. B. R., a sixty-seven year old white man, had a chief complaint of pain in the right upper quadrant of the abdomen for a few weeks. The pain was constant, dull-aching in character and did not radiate. The pain was not influenced by fatty foods. The patient noticed that he was jaundiced and that it was increasing in intensity. Itching of the skin was severe. He had had one previous attack of jaundice which cleared under a medical regimen. There was no weight loss. He had had a prostatectomy four years previously for a benign lesion. Physical examination revealed tenderness in the right upper quadrant. The liver, gallbladder and spleen were not palpably enlarged. Laboratory work-up before admission to the hospital revealed the following: cholesterol, 195; esters, 85; icteric index, 35; alkaline phosphatase, 6.6; and cephalin flocculation tests, 2 plus. The white blood cell count was 7,700 per cu. mm. with 68 per cent polymorphonuclear leukocytes, 1 eosinophil, 1 monocyte and 30 lymphocytes; hemoglobin was 14.5 gm. per cent.

The patient was admitted to the hospital and cholecystectomy was performed. A T-tube was placed into the common duct after an exploratory choledochotomy had been performed. The pathologic report revealed a gall bladder 10 by 4 cm. The wall was very edematous with areas of congestion on the surface. The mucosa was velvety and there were tortuosities of the lumen with formation of compartments at the narrow pole. Microscopic examination showed all the layers to be edematous and infiltrated with lymphocytes and eosinophils. The mucosa formed folds which were covered with columnar epithelium. The epithelium was absent at the tips of a few of the folds.

A delayed cholangiogram which was taken a week later revealed a stricture of the left intrahepatic duct at its junction with the right hepatic. Proximal to the narrowing of the left hepatic duct there was marked dilatation of the duct. The sphincter of Oddi was patent, and the diodrast® was noted in the duodenum and

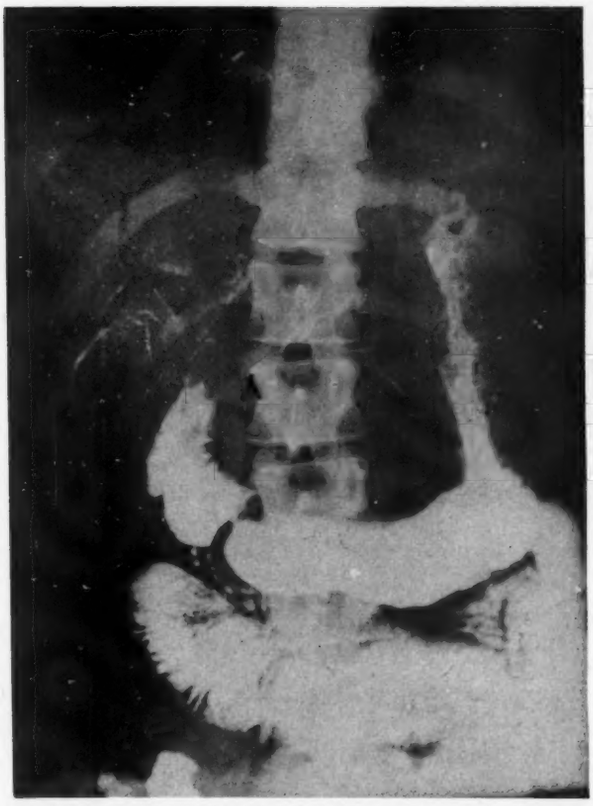

FIG. 6. Case 1. Approximately five months after surgery. Choledochoduodenostomy stoma is patent (A); ducts are not dilated.

FIG. 7. Case 1. Approximately five months after surgery. This film was taken five hours after barium meal.

jejunum. Liver tests taken two weeks later revealed: cholesterol, 305; esters, 120; icteric index, 6; alkaline phosphatase, 9.31 and cephalin flocculation test, 1 plus. Culture of the bile revealed Proteus vulgaris. There was no enzyme in the bile. Repeated cholangiograms one month and four months postoperatively showed the stricture to persist. The T tube was removed after six months. There had been no recurrence of the jaundice or history of chills or fever. The patient has resumed his usual occupation and reports for periodic checkups. (Figs. 8 and 9.)

*Comment:* This case presents a stricture of the left intrahepatic duct which was found at the primary operation. Since no biliary surgery had ever been performed it is impossible to attribute the stenotic lesion to surgical trauma. The stricture came on insidiously and was accompanied by the usual signs and symptoms of obstructive jaundice. There was complete remission following the first attack. The second attack was more severe and the jaundice grew progressively worse. In the absence of stones in either the gallbladder or the common duct one must postulate that cholangitis was present prior to operation and that this condition caused a slowing of the bile flow with formation of a calculus which was extruded into the common duct and produced the jaundice. At operation the stone may have been dislodged by manipulation and probing. If at any future date the obstructive jaundice recurs, the site of the pathologic lesion is known and the necessary surgical measures can be instituted to relieve the obstructive jaundice.

## SUMMARY

1. Two cases of benign stenosis have been presented, one involving an extrahepatic duct and the other an intrahepatic radicle.

2. No calculi were found in either case to account for the obstructive jaundice.

3. In my opinion ulcerative cholangitis existed in both cases prior to any surgical procedure and was the primary factor in the production of the strictures.

FIG. 8. Case II. Cholangiogram taken one week postoperatively reveals benign stricture of the left intrahepatic duct (arrows A and B). (From: WEINER, J. J. and LA CORTE, S. *Am. J. Surg.*, 86: 120–122, 1953.)

FIG. 9. Case II. Cholangiogram taken four months after surgery still reveals the stenotic area (A and B) in the left intrahepatic duct at its junction with the common hepatic duct. (From: WEINER, J. J. and LA CORTE, S. *Am. J. Surg.*, 86: 120–122, 1953.)

4. Immediate operative cholangiography can be an important factor in reclassifying a number of obscure cases of obstructive cirrhosis of unknown origin as conditions which may have been produced as a result of ulcerative cholangitis.

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# Renal Cell Carcinoma Coexisting with Fibrin Calculus

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A WIDE variety of soft radiolucent concretions have been reported as occurring in the human urinary tract. These are a heterogeneous group of varying consistency, loosely classified as fibrin, albumin, colloid, mucin, bacteria and amyloid calculi, occurring either as pure examples of one of these types or as varying combinations of these substances [*1,2*].

While it is generally reported that these stones occur in the presence of renal infection, there is little or no reference made to the possibility that such a concretion may occur in conjunction with a malignant renal tumor in the absence of renal infection demonstrable either clinically or by histologic examination of the surgically removed kidney.

The following case report is presented to illustrate the coexistence of fibrin calculus with a renal cell carcinoma in the right kidney.

## CASE REPORT

A sixty-nine year old white man was first seen on April 5, 1955. He complained of dysuria, frequency of urination and nocturia of six weeks' duration. During this time, gross hematuria was noted three times. There had been no history of renal colic, recent weight loss, chills or fever, or pain in the loin.

Physical examination showed no clinical evidence of anemia. Neither kidney was palpably enlarged, and there was no tenderness at the costovertebral angle. No suprapubic mass could be felt. The external genitalia were normal. There was no varicocele. Rectal examination showed the anal tonus to be normal. The prostate gland was enlarged 3 plus, symmetric and soft, without stony-hard nodules or fixation. Residual urine was 120 cc.

Urinalysis showed microscopic hematuria but was negative for albumin, glucose and leukocytes. Blood non-protein nitrogen, red blood count, white blood count and blood smear were

FIG. 1. Retrograde pyelogram in anteroposterior view to demonstrate upper tracts more distinctly. These tracts were considered to be within normal limits.

all within normal limits. Urine culture yielded no growth. The serologic test for syphilis was negative.

A tentative diagnosis of benign prostatic hyperplasia with obstruction of the bladder neck was made, and the possibility of a tumor of the bladder was considered. An intravenous pyelogram was obtained on April 8th. This showed both kidneys to be functioning well. The possibility of right renal enlargement was

FIG. 2. Photograph of fibrin concretion passed spontaneously in the urine. Grossly it looked like ascaris lumbricoides.

considered and a retrograde pyelogram was obtained in anteroposterior (Fig. 1.) and right lateral oblique views. These films were considered as showing the right kidney to be within normal limits. Cystoscopy showed engorged veins over the surface of the prostate but no evidence of a tumor of the bladder. The bladder was trabeculated. No blood could be seen coming from either ureteral orifice. The hematuria was assumed to have originated in the bladder neck.

On April 9, 1955, a one-stage suprapubic prostatectomy was performed. Postoperative convalescence was smooth, and the patient was discharged on the fourteenth postoperative

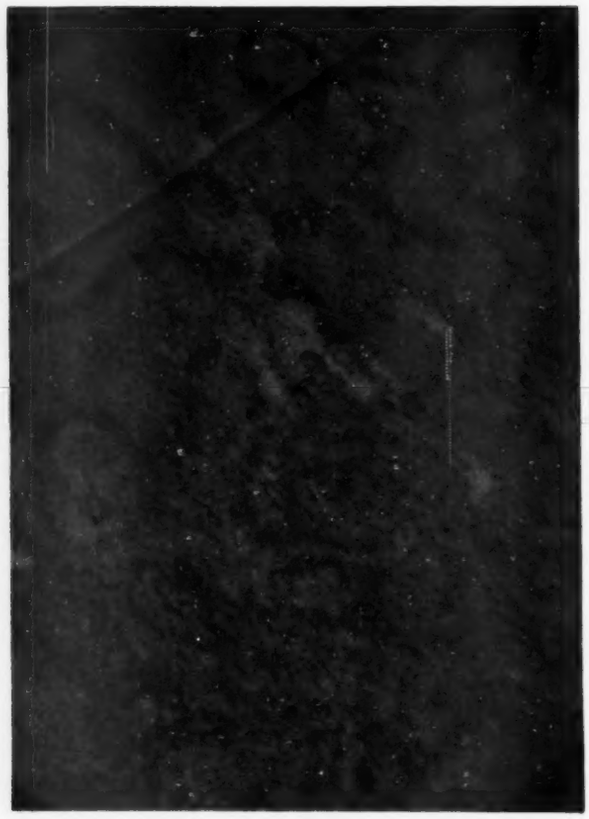

FIG. 3. High power view of slide taken of fibrin stone showing fibrin with scattered epithelial cells and some infiltration with lymphocytes and monocytes. No bacterial colonies are demonstrated. Careful search was made for the presence of exfoliated renal cancer cells in the slide but none could be seen.

day. He was able to void with an excellent stream and had normal urinary control. Pathologic report of the prostatic tissue was benign prostatic hyperplasia.

The patient was then well until July 5th when he spontaneously passed a long, white, cylindric concrement which grossly looked like a round worm. (Fig. 2.) Histologic examination of this revealed it to be a fibrin "stone." (Fig. 3.)

The patient continued to pass long white worm-like fibrin casts in his urine and so cystoscopy was repeated on July 8th. A right retrograde pyelogram (Fig. 4) now showed a remarkable change from the preprostatectomy film. There was evidence of a large filling defect involving the renal pelvis, calyces and upper ureter. It was believed that this defect was due to the presence of fibrin stone in the right upper urinary tract, and that the patient was passing fibrin casts of his right ureter. The

FIG. 4. Repeat retrograde pyelogram taken three months postprostatectomy now shows a filling defect in the right renal pelvis and upper ureter. This filling defect was considered to be due to the fibrin stone filling the pelvis, calyces and upper ureter.

FIG. 5. Retrograde pyelogram taken before surgical exploration of the right kidney. Now the fibrin stone has produced virtually complete right ureteropelvic obstruction and the injected dye is seen to regurgitate back down the ureter around the catheter. The ureteral segment of the fibrin stone had been passed and the right lower ureter is now free of fibrin stone.

urinalysis showed only 15 to 20 white blood cells and 5 to 6 red blood cells per high power field. There was no fever, no pain in the flank or tenderness in the loin. The cellular elements in the urine were considered to originate from the epithelializing prostatic fossa, postprostatectomy.

After vigorous courses of chemotherapeutic and antibiotic drugs, including gantrisin,® terramycin,® aureomycin, chloromycetin® and furadantin,® the urine culture yielded no growth. The patient continued to pass these worm-like ureteral fibrin casts. It then seemed reasonable to consider possible dissolution of these large fibrin stones filling the right ureter with a fibrinolytic enzyme preparation such as streptokinase-streptodornase [*11*] (varidase,® Lederle).

However, in October, the patient noted gross hematuria on two occasions. A repeat retrograde pyelogram was obtained on October 10th, and again in November. (Fig. 5.) Urine cultures yielded no growth. At this point a renal tumor was suspected in addition to fibrin stones, and surgical exploration was recommended. Chest x-ray showed no evidence of metastases.

Right renal exploration was performed on November 12, 1955, and an encapsulated renal tumor (Fig. 6) was found in the lower pole along with a stag-horn type of fibrin stone filling the renal calyces, pelvis and upper ureter. A radical nephrectomy of the Foley type was carried out [*12*].

Microscopic examination revealed a typical renal cell carcinoma of the lower pole of the right kidney, and a stag-horn type of fibrin stone filling the renal pelvis, calyces and upper ureter. Since nephrectomy, the patient has been asymptomatic, his urine free of cellular elements, and he has passed no more "fibrin worms."

## COMMENTS

Characteristically, these concretions are radiolucent but at times varying degrees of infiltration with calcium salts may occur and impart some radiopacity to the stones. They may occur as solitary or multiple concretions and may be present in the same kidney or

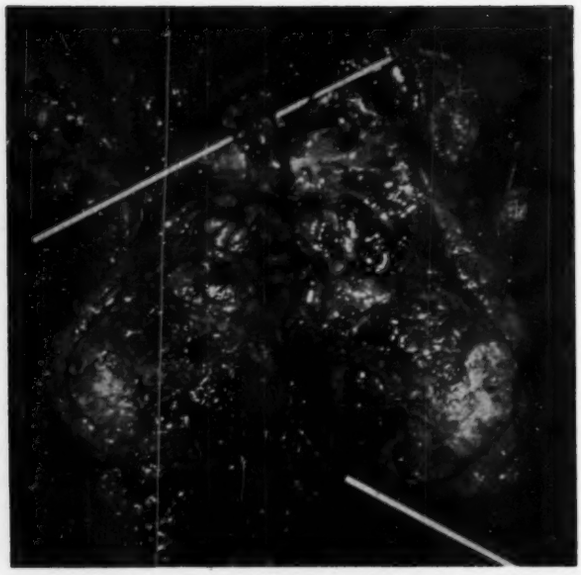

FIG. 6. Photograph of bisected right kidney demonstrating a well encapsulated renal cell carcinoma of the lower pole of the kidney invading the lower calyx. The fibrin stone fills the renal pelvis, upper and middle calyces and upper ureter. The kidney is surrounded by Gerota's fascia. The renal vein was not invaded by tumor.

FIG. 7. Low power view of section taken through the kidney. At the upper margin, one sees renal cell carcinoma, (CA) adjacent to a triangular wedge of fibrin, (F) separated slightly from a layer of transitional cell epithelium (E) of a calyx (in the middle of the field) which shows slight subepithelial infiltration with a few lymphocytes and monocytes.

bladder along with calcium stones. They have been described as white, gray, grayish yellow or brown in color; soft, elastic and having the consistency of a cooked lima bean or putty [3]. In the case reported herein the consistency of the stone as felt in the ureter at the time of operation was that of a boiled frankfurter.

Microscopically, these stones have shown fibrin with varying amounts of unorganized debris and a total absence of any cellular structure. At times, one can see laminations of amorphous debris, fibrin and crystals [4,5,6].

Not much is known regarding the pathogenesis of this type stone. Much emphasis has been placed on the role that infection plays in this disease, the usual organisms being Bacterium coli and Staphylococcus aureus. Some stones have been reported as occurring in a tuberculous kidney [6].

In addition to renal or bladder infection, other factors have been implicated such as derangement of metabolism and changes in the physicochemical characteristics of the urine possibly secondary to bacterial activity. One idea is that blood clots or necrotic filaments loosened from the renal pelvis in cases of pyelonephritis or pyonephrosis constitute a nutritive medium for invading bacteria and thus form the albuminous framework of the calculus.

The role of hematuria in the formation of a fibrin stone is not clear. While Gage and Beal [7] believe that hematuria is an essential prerequisite to the development of a fibrin stone, it has been shown by Smith and Wood [8] that fibrin formation is a common feature of acute inflammations. Fibrinous exudates occur in acute bacterial infections and enhance the antibacterial defenses of the body by promoting surface phagocytosis. Thus it would appear that any bacterial exudate could serve as a potential source of fibrin even in the absence of hematuria. In 1928 Hyman [1] in a review of the literature of the previous twenty-five years, was able to find twenty-two cases of albumin, fibrin and bacterial calculi without calcification. He reported three cases, all occurring in patients with infected bladders, postprostatec-

tomy. None of the cases reviewed by Hyman were in association with renal neoplasm.

Review of the literature since 1928 brought to light only two cases similar to the one reported above. This was a report by Weber [9] in 1935 of a sixty-four year old man who, at autopsy, was found to have a small renal cell carcinoma of the left kidney with pulmonary metastases and four fibrinous bladder calculi. These showed onion-like fibrinous laminas. One of them was hollow and attached to a long, string-like fibrinous cord. There was a casual reference to a second case that of a thirty-four year old woman, with a Grawitz tumor of the right kidney, showing "old thrombus curiously shaped like an ascaris lumbricoides in the right ureter." Weber in these reports made no mention of any possible etiologic relationship between the renal neoplasm and the fibrin stones.

In the case cited, it is apparent that there was an unfortunate delay in diagnosing the tumor in the right kidney because of the presence of the fibrin stone visualized in the pyelograms. Tumor in the same kidney was suspected only after hematuria recurred and the fibrin stone continued to form and be passed through the urethra despite sterilization of the urine. The observation that fibrin stone may develop even in the absence of demonstrable urinary tract infection is worthy of recording.

Another point of interest is the phenomenon of the spontaneous passage of these long cylindric concretions which looked like ascaris lumbricoides. However, on careful examination of the filament it was found to have an homogeneous consistency and its diameter and length suggested its ureteral origin.

At operation the upper ureter was found to measure 1.5 cm. in diameter and had the consistency of a boiled frankfurter. This was due to distention with fibrin stone which was much firmer in consistency than the fibrin coagulum produced by adding fibrinogen to thrombin in accordance with the Dees technic of coagulum pyelolithotomy [10].

It is of interest that the kidney did not show gross or microscopic evidence of acute pyelonephritis or pyonephrosis. Some microscopic sections showed fibrin near the tumor, contiguous with malignant renal cells, close to normal-looking transitional epithelium of the renal calyx. (Fig. 7.)

In retrospect after the discovery of the tumor in the kidney, the slide of one of the ureteral casts was re-examined to see if any nests of renal tumor cells could be seen as exfoliated cancer cells in the fibrin network but this search revealed none.

While it would be possible to assume that these two lesions were fortuitous occurrences in the same kidney without pathogenetic relationship, it would seem more reasonable to suggest that the presence of the tumor was responsible for the fibrin, either through bleeding produced by neoplastic erosion of the lower calyx or by eliciting in the renal substance an inflammatory reaction which, *per se*, provided the fibrin necessary to form the stone. Whatever the mechanism, it is important to note that there was no significant renal infection.

## SUMMARY

A case is reported of a patient with a fibrin calculus who on exploration was found to harbor a previously unsuspected renal cell carcinoma.

The point is made that, while fibrin calculi are usually associated with renal infection, one must not overlook the possibility of renal malignancy as the underlying pathologic process.

The passage of "long white worms" in the urine should suggest the possible presence of a fibrin stone.

The suggestion is made that fibrinolytic enzyme preparations such as streptokinase-streptodornase, introduced through an ureteral catheter, may be worthy of trial in the dissolution of fibrin calculi in instances in which malignancy can be ruled out.

This makes the third case of renal cell carcinoma coexisting with fibrin calculus to be reported in the literature.

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# Multiple Intracranial Meningiomas

## CASE REPORT OF TWO SEPARATE MENINGIOMAS REMOVED THROUGH SEPARATE CRANIOTOMIES AT ONE OPERATION

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MULTIPLE primary tumors of the central nervous system or its coverings are extremely rare. Cases in which there is more than one primary tumor of the same type are even more rare. The literature on the subject has been thoroughly reviewed by others [*1–11*]. The number of recorded cases in which multiple meningiomas have been successfully removed from the brain is probably no more than five. Craig and Raaf reported a case in which three closely adjacent meningiomas were removed through the same operative exposure. These tumors were similar microscopically. Woltman and Love reported a case in which the meningioma was found in the middle fossa coming up from beneath the right temporal lobe and even presenting in the right external auditory canal. A second operation revealed a large meningioma in the right posterior fossa along the base beneath the cerebellar hemisphere. The anatomic proximity again is extremely close although the surgical proximity of the two presentations is widely separated. In each of Mufson's two cases, two meningiomas were removed through the same operative flap, in one instance at the same operation and in the other at a separate operation. Some of these meningiomas in such close proximity raise the question of actual continuity. Cushing's tremendous series contained three cases of multiple discreet meningiomas. There are several other cases which are better described as meningeal meningiomatosis as reviewed by Uihlein and his co-workers.

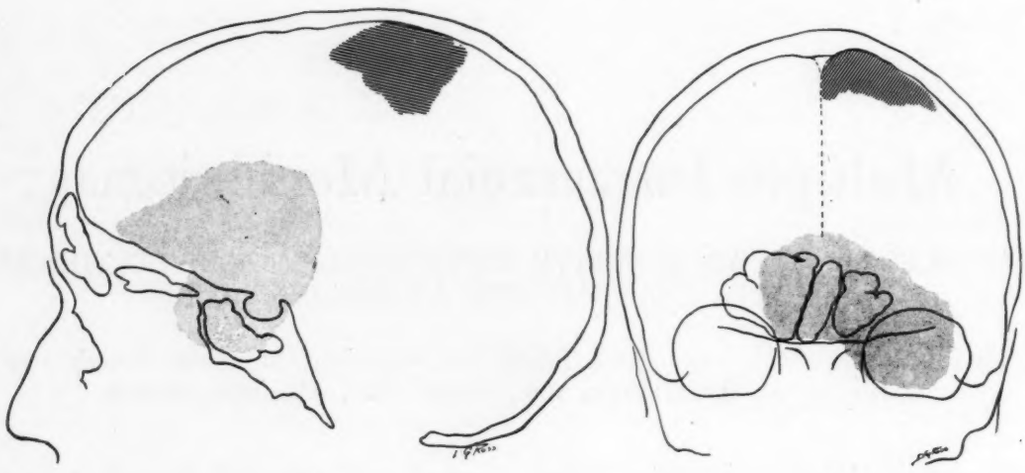
The case reported here is believed to be the first in which two meningiomas were anticipated and removed through two separate craniotomies during one operation.

### CASE REPORT

In November, 1954, M. S., a thirty-three year old man noted the onset of repeated abrupt attacks of severe throbbing headache, tremor of the hands and inability to speak clearly. Shortly thereafter he noted the gradual onset of generalized headache which was aggravated by quick movement or by arising from the prone position. One brother had grand mal epilepsy, otherwise the family history was non-contributory.

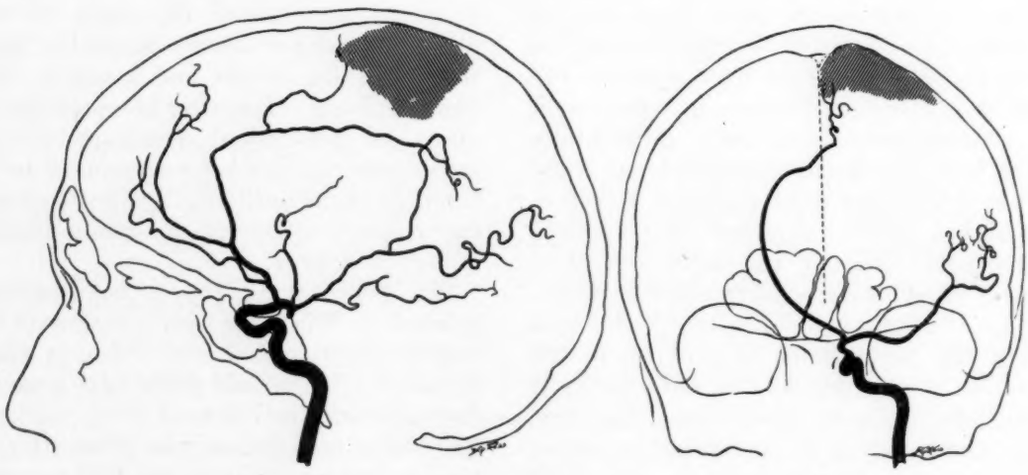
On February 5, 1955, the patient was referred to Winnipeg with a diagnosis of brain tumor. Neurologic examination at that time revealed an increased ankle and knee jerk on the right side and bilateral acute papilloedema. Skull films revealed an area of spotty calcification near the midline on the left almost at the vertex. (Fig. 1.) An electroencephalogram on February 14th was thought to be within normal limits although there was some diminution of alpha activity in the right parietal area and a wide range of photic following on the left as compared to the right.

On February 10, 1955, a left carotid angiogram (Fig. 2A and B) revealed minimal displacement of the vessels adjacent to the spotty calcification in the parasagittal region at the vertex. There was a surprisingly great curvilinear displacement from left to right of the anterior cerebral artery. This was not at all in proportion to the minimal displacement of the vessels in the calcified area and hence indicated another mass low in the anterior fossa. There was no local vascularity in any phase of the



1A 1B

FIG. 1. A and B, drawings made from sketches at operation indicating the location and size of the tumors. The heavy cross hatching at the vertex represents the actual extent of visible calcification on the plain x-ray films which corresponded in area to the size of the tumor as found at surgery. The faint stippling represents the extent of the sphenoid ridge meningioma.



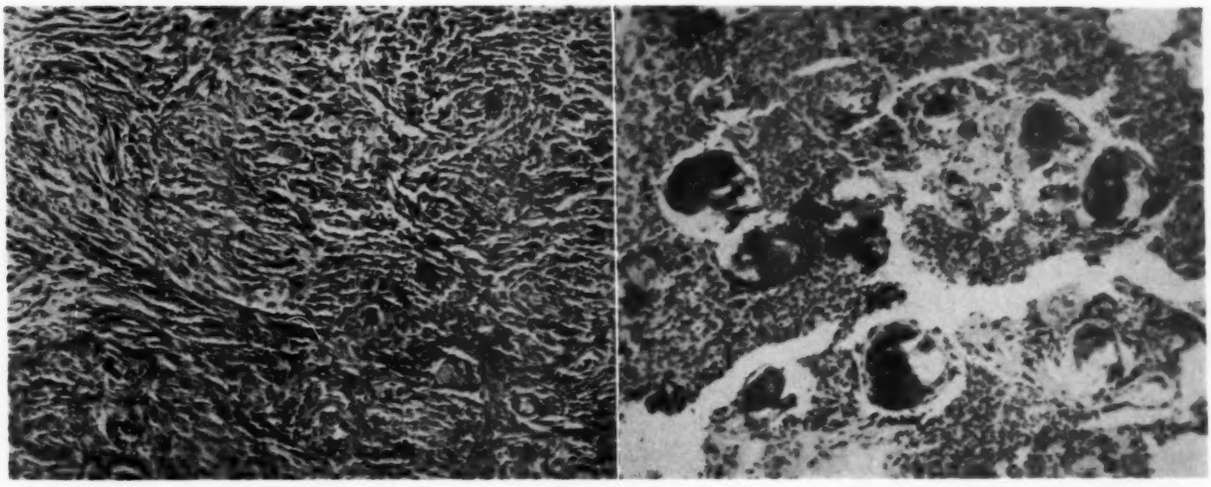
2A 2B

FIG. 2. A, tracing of the lateral projection of the arterial phase of the angiogram showing the very minimal displacement of the vessels adjacent to the spotty calcification in the parasaggital region at the vertex. B, tracing of an anterioposterior projection of the angiogram illustrating the large curvilinear displacement of the anterior cerebral from left to right. The capillary and venous phases of the angiogram did not reveal any tumor cloud.

angiogram to give an indication as to the type of tumor.

The additional pressure of the second tumor was going to be a problem no matter which lesion was attacked first. It was planned to remove the parasagittal lesion first because it was the more accessible.

The operation was performed on February 14, 1955. A free bone flap was turned over the posterior parietal region near the vertex, exposing the parasagittal area. A meningioma was encountered not particularly adherent to either the dura or the underlying brain. The tumor spread out along the surface in all directions including down along the falx, but at no place was more than 1 inch in total thickness. As the tumor was removed, the brain began to herniate in an alarming fashion. The cortex ruptured and it was impossible to close the dura. Large packs were sutured over the area as they were held forcibly in place and the skin flap anchored over these with towel clips. The



3A 3B

FIG. 3. A, picture of a representative section of the tumor near the vertex which revealed the spotty calcification by x-ray. The numerous large calcified psammoma bodies are easily identified. × 100. B, field from the tumor of the sphenoid ridge. There are occasional small psammoma bodies but for the most part it has the pattern of a fibroblastic meningioma. Both these sections are identical magnifications although because of the larger psammoma bodies 3A appears to be of much higher magnification. If the actual cell size is noted the similarity of magnification is apparent. × 100.

patient was immediately redraped and a transfrontal craniotomy performed which exposed the huge meningioma on the left sphenoid ridge. This extended as indicated in Figure 3A and B. The entire tumor was eventually removed leaving the front of the middle fossa, the sphenoid ridge and the anterior fossa completely bare inferiorly on the left. The optic nerve and chiasm were stretched laterally and down, lying across the region of the pituitary fossa.

Postoperatively the patient had no movement in his right arm but his speech was intact as was his leg movement. He was up and walking about the ward three days postoperatively. Six days postoperatively movement returned to the upper part of the right arm. The next day there was movement at the elbow and wrist and the following day movement returned to the thumb.

The patient was dismissed from the hospital on February 24. He has returned to his farm work. There has been a gradual return of normal function to the right upper extremity and at present the patient can notice no difference. He is completely free of his headaches and has had no further seizures to date. (Fig. 4.)

FIG. 4. Postoperative photograph of patient showing the two craniotomy flaps.

## COMMENTS

This case emphasizes the value of performing visualization studies even with straightforward x-ray evidence of a neoplasm entirely compatible with the clinical picture. The ordinary x-ray films revealed unequivocal evidence of a meningioma in a location which could well produce the man's neurologic disturbance. If the angiogram had not been performed preoperatively the location of the second meningioma could never have been determined. Interrupting the operative procedure and attempting either an air study or an angiogram would have been disastrous. The cerebral bulging was uncon-

trollable and as it was resulted in considerable disruption of cortex. Fortunately, the man eventually recovered usage of the arm.


SUMMARY

A case is presented of two widely separated and histologically different meningiomas with successful removal at one stage via two separate craniotomies. The value of preoperative intracranial visualization studies even with obvious radiographic localization is emphasized.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Various surgical procedures are available for the treatment of repeated venous hemorrhages from the lower esophagus. Some prefer thoracotomy with extraluminar or intraluminar ligation of the bleeding esophageal varices; others prefer a portacaval shunt, a splenorenal shunt or a mesenterocaval shunt. Phemister has recommended his method of anastomosis after resection of the upper part of the stomach and the lower portion of the esophagus; other surgeons have sought to treat this condition by ligation of the splenic and left gastric arteries plus ligation of the hepatic artery, etc. This latter procedure may occasionally be successful but it is more dangerous to the patient (because of possible onset of postoperative gangrene) than are the various venous shunt operations. We must not forget that patients with cirrhosis of the liver are greater surgical risks than patients with portal hypertension due to extrahepatic causes, and govern our surgical procedures accordingly. (*Richard A. Leonardo, M.D.*)

# Fate of Barium Sulfate in the Retroperitoneum

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THERE are numerous reports in the medical literature of barium entering the peritoneal cavity after rupture of peptic ulcer or other portions of the gastrointestinal tract during or after x-ray examination [*1–4,8,10,13–15*]. In the case reported herein barium entered the retroperitoneal space through a fistula in the retroperitoneal portion of the duodenum, with no adverse effect on the convalescence or survival of the patient. Experiments on rabbits concerning the lesions produced by barium in the retroperitoneum are also reported.

## CASE REPORT

H. O., a fifteen year old white boy, was brought to the Highland Park General Hospital on November 30, 1952, with a gunshot wound in the abdomen. There was a small, round bullet wound approximately 1 inch to the right of the navel in front; the point of exit posteriorly was 2 inches to the right of the second lumbar vertebra. Palpation revealed spasticity, tenderness and rigidity in the entire right side of the abdomen. The patient's blood pressure was 100/80, the pulse 90. Flat x-ray plate of the abdomen showed no evidence of a metallic foreign body or of free air in the peritoneal cavity. There was frank blood in the catheterized urine specimen. Abdominal operation was undertaken through a right rectus vertical incision with the navel as the center, and was later extended with a right transverse incision to the flank.

The peritoneal cavity was found to be filled with clotted and fresh blood. The examination disclosed no injury to the liver, spleen, stomach or left kidney. A large hematoma was noted in the gastrocolic omentum, and the bleeding branches of the right gastroepiploic artery were ligated. In the region of the right kidney there was a large hematoma containing fluid blood. The upper half of the right kidney was found to be reduced to a pulp-like substance and there was profuse bleeding from the renal pedicle. This structure was clamped and ligated, and the macerated kidney removed. On retracting the parietal peritoneum medially, the duodenum was exposed. At the junction of its second and third portions the duodenum was found to have two holes, one opposite the other, approximately 1½ cm. in diameter, with bile discharging from them. Both these openings were closed with an inner layer of continuous No. 0000 chromic catgut and reinforced with interrupted No. 000 silk. The integrity of the small and large intestine was ascertained. All the bleeding was checked. The retroperitoneal space of the operative sites was drained.

Tetanus and gas bacillus antitoxin were given before the patient left the operating room. The patient received 1,500 cc. of whole blood before and during the operation.

Postoperative treatment consisted of continuous gastric suction by Levin tube, antibiotics, electrolytes intravenously and whole blood transfusions.

The postoperative course was marked by intermittent nausea and vomiting, but peristalsis was active and the patient was able to eat. However, intermittent vomiting continued. On the eighth postoperative day a barium meal revealed that the stomach and cap filled well. The cap was unusually large and there appeared to be evidence of irregularity at the second and third portions of the duodenum around the operative site. Fluoroscopically no other lesions were visualized; however, the

FIG. 1. Roentgenogram showing retroperitoneal duodenal fistulous tract (between arrows).

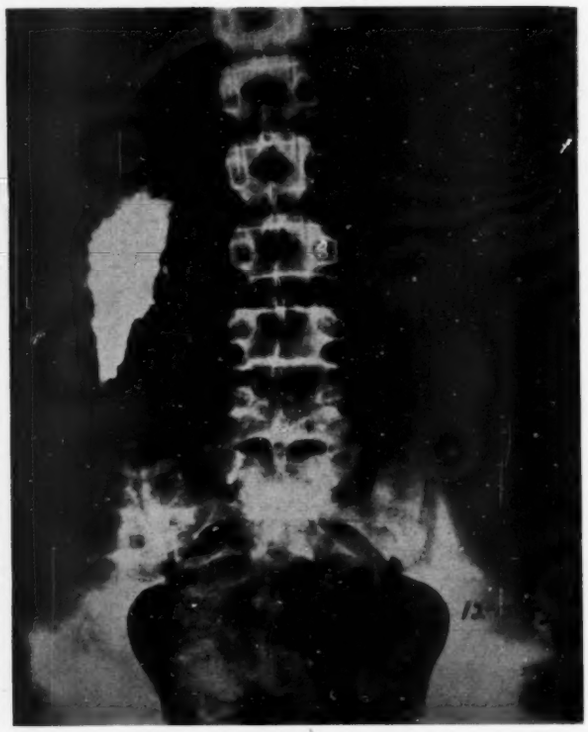

FIG. 2. Roentgenogram taken one week after ingestion of barium showing pool of barium in retroperitoneal space between the second and third lumbar vertebrae.

serial films showed an apparent fistulous tract extending from the second portion of the duodenum to the right side and downward. (Fig. 1.) Despite the presence of a duodenal fistula there was no evidence of perforation, shock or peritonitis, nor was there any bile stain on the dressings. The progress of the barium was followed, and in twenty hours it was in the terminal ileum and colon.

The patient continued to improve and on the thriteenth postoperative day, five days after ingestion of barium, the temperature, pulse and respiration remained normal, and he was ambulatory and ate well. After cleansing the bowel of barium, a moderate amount of the barium was found lying on the right side between the transverse processes of the second and fourth vertebrae. (Fig. 2.)

On the fifteenth postoperative day, seven days after ingestion of barium, x-ray films showed the same amount of barium in the same location.

On December 18th, the eighteenth postoperative day, the patient was discharged from the hospital. He felt well and was afebrile. He enjoyed his food and appeared completely recovered.

Two and three (Fig. 3) years after the episode x-rays of the abdomen showed the same amount of barium in the retroperitoneum. The patient has been gainfully employed and plays baseball for recreation.

## EXPERIMENTAL DATA

In order to determine the fate of barium extraperitoneally, ten rabbits weighing from 2 to 2½ kg. were anesthetized by injecting nupercaine® intraperitoneally, using 50 mg. nupercaine per kg. body weight. Through a dorsal incision 1 to 3 cc. of barium mixture were implanted retroperitoneally. The muscle, fascia and skin were sutured in layers with silk.

The rabbits were divided in two equal groups. In Group A the barium mixture used was autoclaved and in Group B it was not sterilized. The following day all the rabbits were x-rayed and all showed the radiopaque medium in the extraperitoneal space. After approximately two months the ten rabbits were x-rayed again, with the same roentgenologic findings. They were then sacrificed.

Autopsy was performed on all the rabbits. The internal organs were grossly normal. There was no evidence of the presence of barium any-

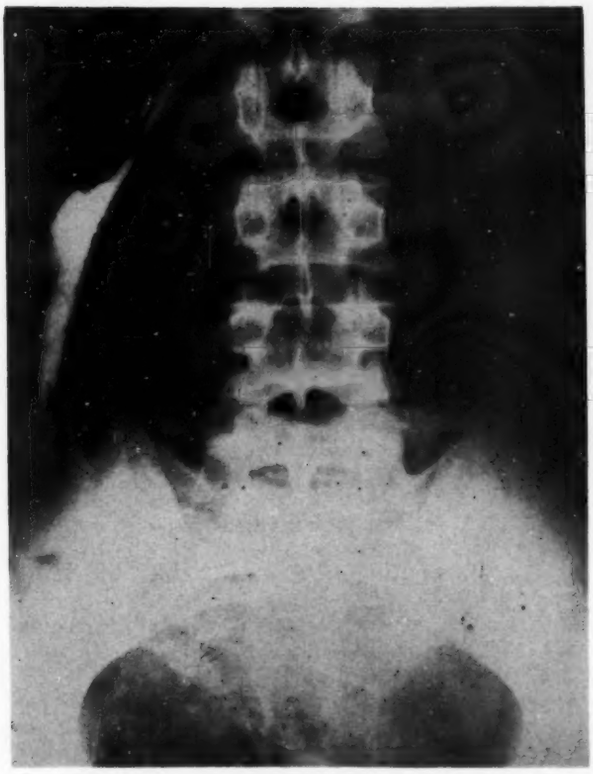

FIG. 3. Roentgenogram showing persistence of barium after three years, the barium showing a tendency to gravitate downward.

where in the body other than at the site of implantation.

At the operative site the wounds were well healed. The skin was freely movable over the lesions. The subcutaneous tissue and muscle contained rounded to ovoid lesions ranging from 1 to 2.5 cm. in greatest dimensions. They were encapsulated and contained gray-white, pasty material. The peritoneum overlying the lesion was usually free from hyperemia or thickening. (Fig. 4.)

Microscopically the lesions proved to be localized with thick fibrous capsules, sometimes forming multiple loculations. The spaces were occupied by necrotic debris and gray-black granular material (barium), for the most part contained in macrophages. In a few of the lesions considerable polymorphonuclear cellular infiltration was evident. In some instances non-encapsulated groups of phagocytes extended between muscle bundles. Foreign-body giant cells were few in some areas. There was no difference between the amount of polymorphonuclear or fibrotic reaction to sterile or non-sterile barium. (Fig. 5.)

FIG. 4. Gross appearance of barium in retroperitoneum of rabbit two months after implantation, showing circumscribed nodule without significant active inflammation. In the lower right portion the barium infiltrates adjacent muscle planes.

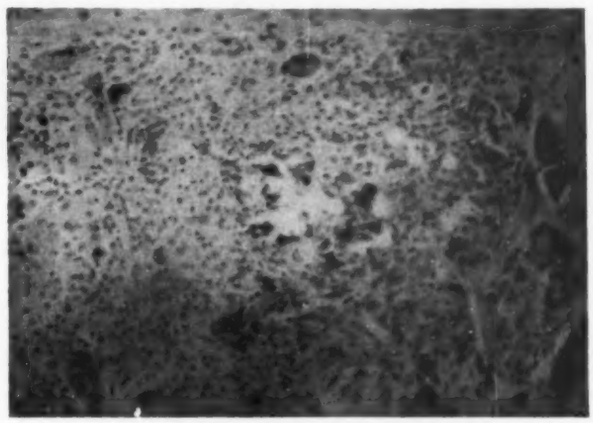

FIG. 5. Photomicrograph of experimental lesion showing central necrotic debris, barium (black amorphous material), numerous macrophages and foreign-body giant cells surrounding fibrous tissue.

## COMMENTS

As one reads the numerous reports on rupture of the gastrointestinal tract following barium ingestion or barium enema, the impression is gained that when barium is spread inside the peritoneal cavity the outcome is invariably related to the peritonitis which ensued and the treatment rendered for the latter [1,2,4,8,10,13] as well as to the time interval between the perforation and surgery.

Barium sulfate left in the peritoneal cavity is always associated with adhesive bands in which barium becomes incorporated [4,6]. Most of the barium is phagocytosed by macrophages, with foreign-body giant cells being formed only

in the later stages when encapsulation and granulation take place [*11,12*]. There appears to be general agreement that barium in small amounts may remain localized in the peritoneal cavity for an indefinite period without causing local complications or signs of toxicity [*9,11,13,15*].

The experimental lesions in the retroperitoneum of rabbits produced in the present experiments were similar to those described in the peritoneal adhesions of the cases cited heretofore. There is every reason to believe that the experimental lesions would have remained indolent for an indefinite period. The lesions were also similar to those produced in the peritoneal cavity of dogs [*4*] where it was also determined that formation of adhesions was related to the occurrence of infection rather than to the barium.

It may be concluded from the case reported herein and from the experimental evidence that barium became implanted in the retroperitoneum without significant infection and that the foreign material *per se* is not harmful and of no more than local significance. It is rather uncommon that the survival from what must have been a retroperitoneal perforation should have occurred without surgical intervention. This may also be attributed to the relative absence of infection, since the perforation was at the duodenum, as well as to the antibiotic therapy at the time and after the episode.

## SUMMARY AND CONCLUSIONS

A case has been reported in which the course of barium in the retroperitoneal space has been observed for three years. In this fifteen year old boy with a gunshot wound through the right abdomen, the right macerated kidney was removed and a two-layer closure of two holes in the retroperitoneal portion of the duodenum was performed. On the eighth postoperative day roentgen barium meal study of the gastrointestinal tract revealed a retroperitoneal duodenal fistula. This did not interfere with the convalescence of the patient who, three years later, is enjoying good health and is engaged in a gainful occupation. X-ray of the abdomen at this time still shows the same amount of barium in the retroperitoneal renal space.

Experiments in which barium sulfate was implanted in the retroperitoneal space of rabbits and observed for one to two months revealed that the barium caused no reaction in the endothelium of the parietal peritoneum and that there was very little difference in the polymorphonuclear or fibrotic reaction in the muscle or subcutaneous tissues to the sterile or non-sterile barium.

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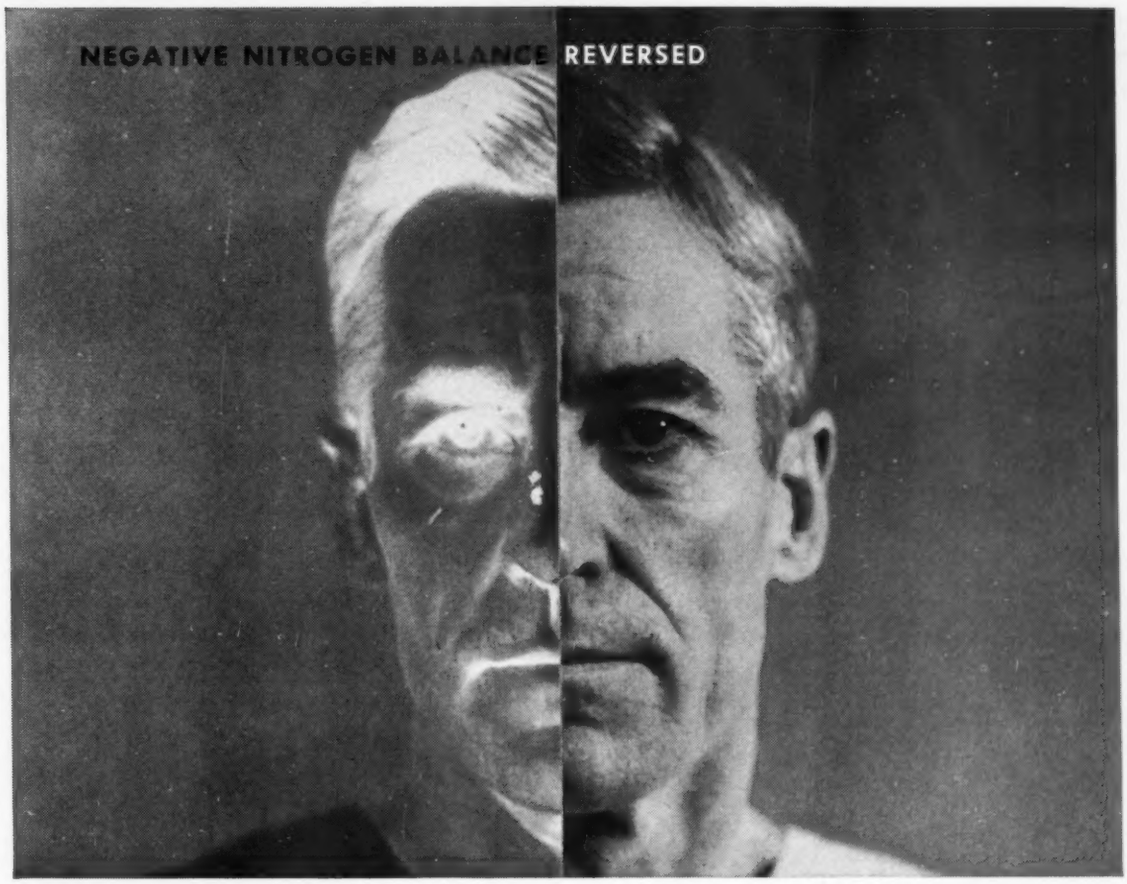


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Surgery of Colon & Rectum, One Week, June 10
Basic Principles in General Surgery, Two Weeks, July 8
Surgical Anatomy & Clinical Surgery, Two Weeks, June 17
Thoracic Surgery, One Week, June 10
Esophageal Surgery, One Week, June 17
Breast & Thyroid Surgery, One Week, June 17
Gallbladder Surgery, Three Days, June 24
Surgery of Hernia, Three Days, June 27
Fractures & Traumatic Surgery, Two Weeks, June 17

GYNECOLOGY—Office & Operative Gynecology, Two Weeks, June 17
Vaginal Approach to Pelvic Surgery, One Week, June 10

MEDICINE—Electrocardiography & Heart Disease, Two-Week Basic Course, July 8
Hematology, One Week, June 17

RADIOLOGY—Diagnostic X-Ray, Clinical Course, by appointment
Radium Therapy, One Week, June 24

CYSTOSCOPY—Ten Day Practical Course by appointment

PEDIATRICS—Neuromuscular Diseases; Cerebral Palsy, July 8

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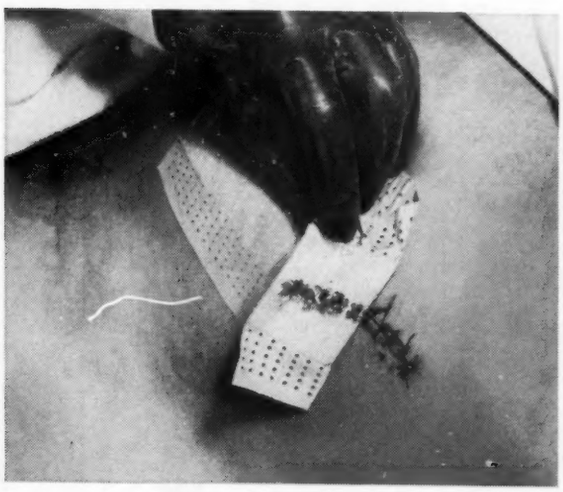

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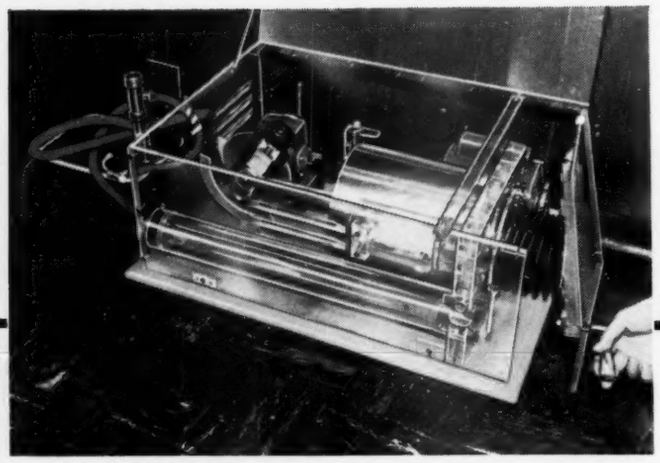

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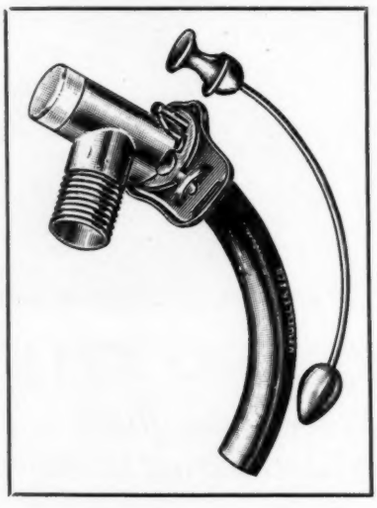

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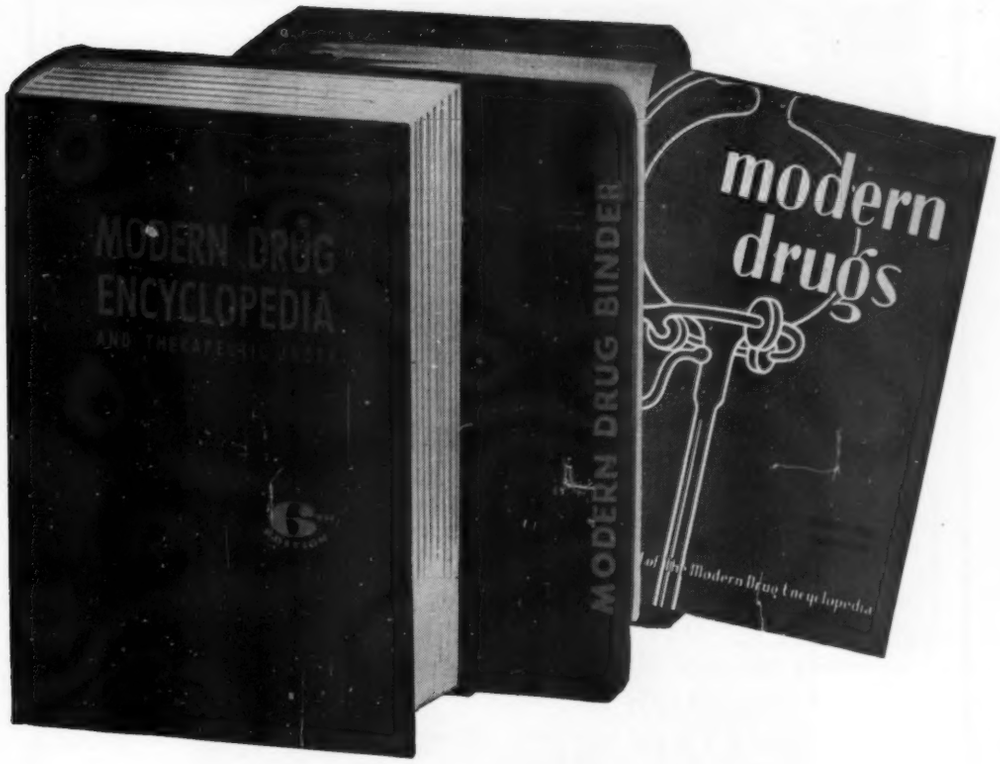


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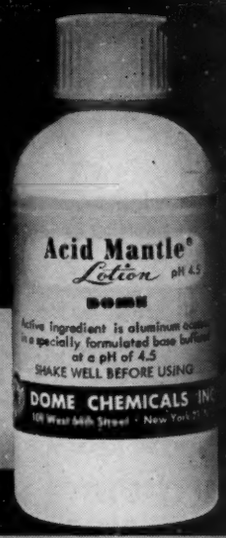


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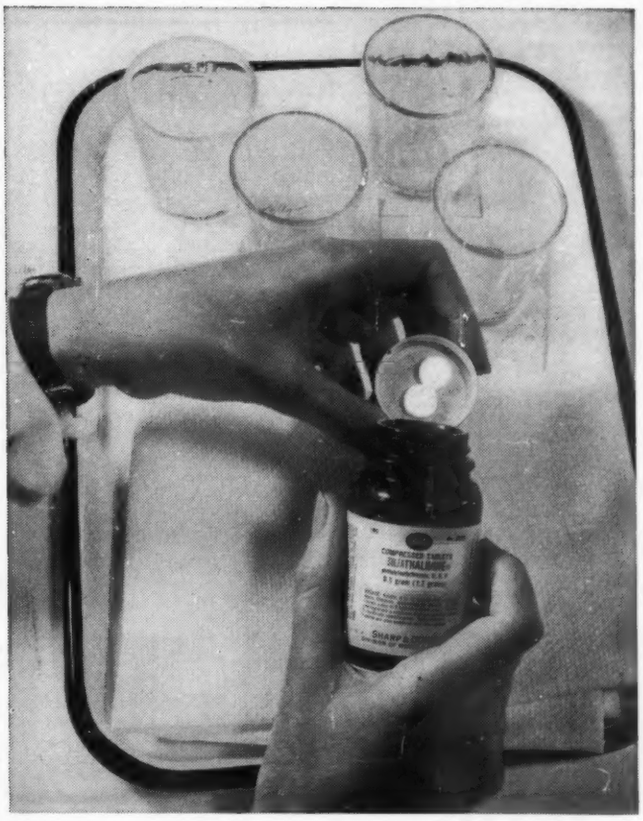

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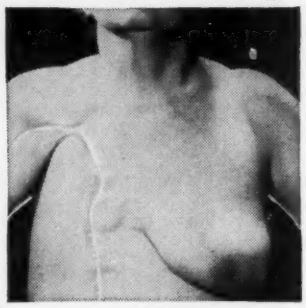

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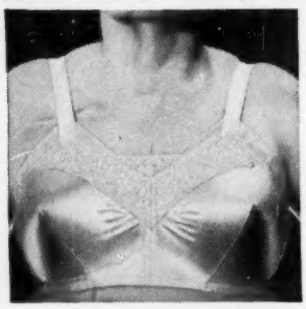

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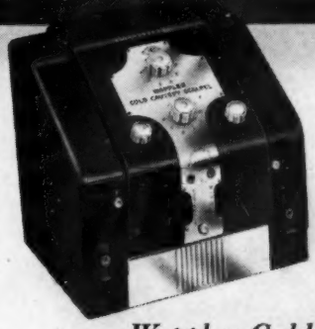

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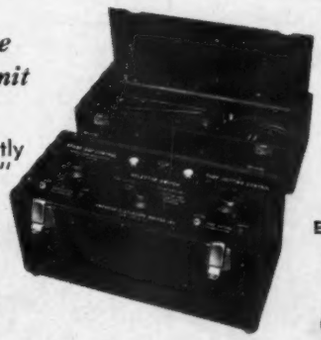

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| Pyridoxine HCl ($B_6$) | 5 mg. |
| Sodium Pantothenate | 10 mg. |
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| Folic Acid | 3 mg. |
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Xylocaine HCl Solutions are available in 2 cc. ampuls, 20 cc. and 50 cc. vials in strengths of 0.5%, 1% and 2%, with or without epinephrine.

Bibliography of approximately 300 Xylocaine references upon request.

*Southworth, J. L., and Dabbs, C. H.: Xylocaine: a superior agent for conduction anesthesia, Anesth. & Analg. *32*:159 (May-June) 1953.

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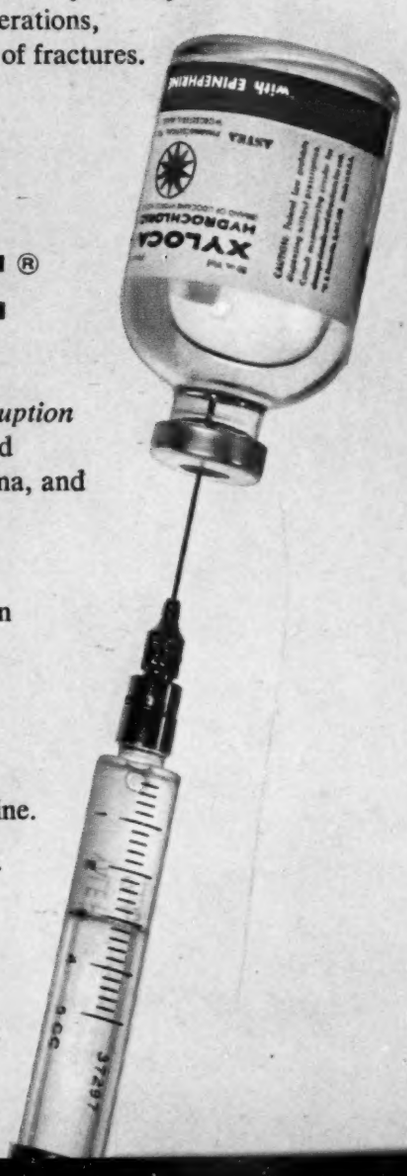

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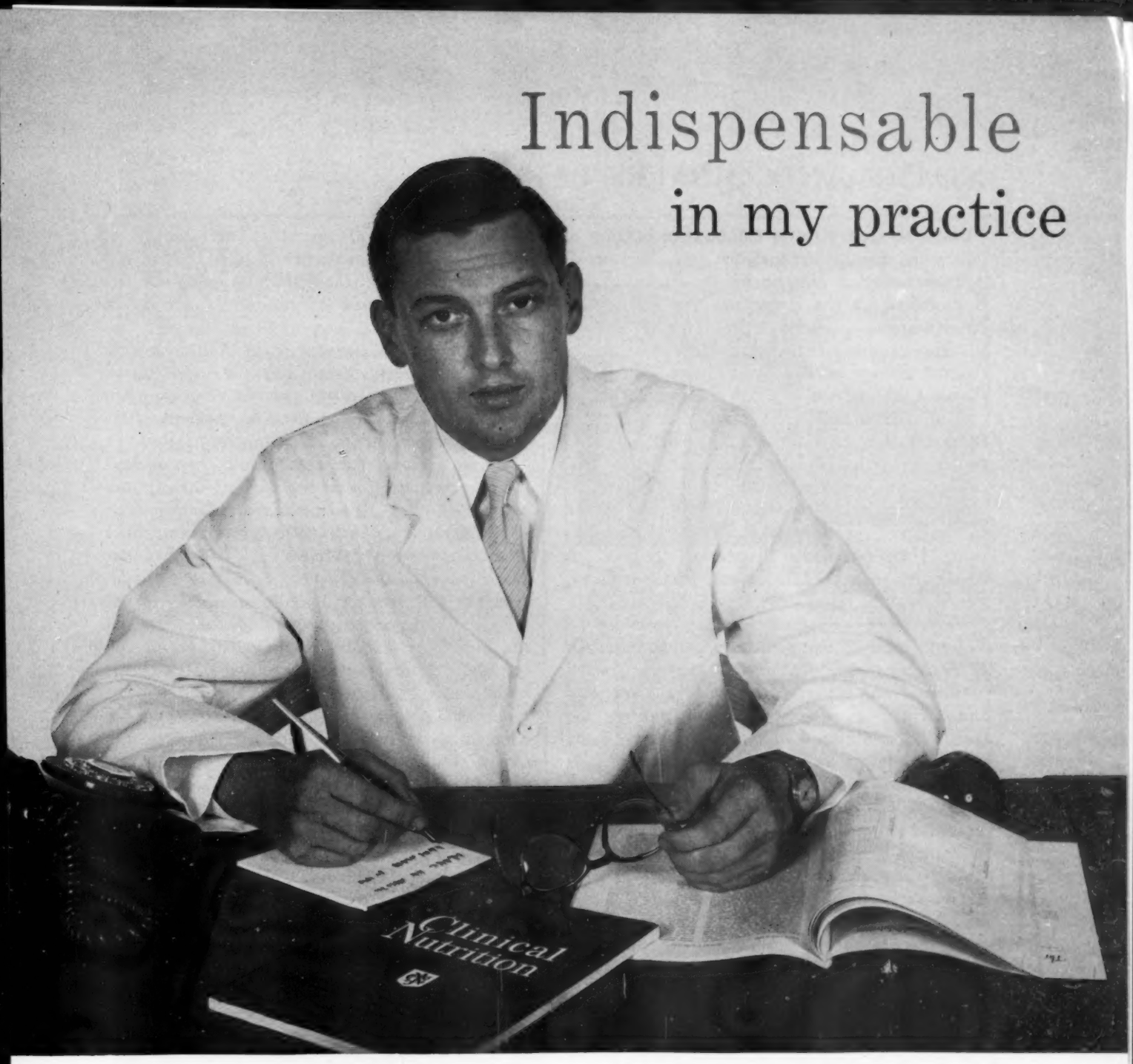


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# NOTES AND QUOTES

THE UNIVERSITY OF PITTSBURGH School of Medicine, Department of Surgery, Section of Anesthesiology, announces a Postgraduate Symposium on the Basic Sciences Related to Anesthesiology. The Symposium will be held in cooperation with the Departments of Anesthesiology of the St. Francis, Allegheny General, Mercy and Medical Center Hospitals.

The course will be held June 10–14, 1957, from 9:00 A.M. to 6:00 P.M., and will be limited to fifty participants.

Registration (fee is $25.00) and full particulars can be obtained from: Chairman of the Committee on Graduate Medical Education, University of Pittsburgh School of Medicine, 3941 O'Hara Street, Pittsburgh 13, Pennsylvania.

*Voluntary health insurance now pays more than 25 per cent of the total annual expenses for all personal health services incurred by both insured and uninsured persons in this country, the Health Information Foundation reports. In the past eight years the proportion of the nation's total medical expenses met by voluntary health insurance has increased three times as fast as the proportion of Americans holding such insurance.*

*According to the Foundation, the average American incurred total charges of $71.50 for medical care and services in 1956. In the same year, the average person covered by voluntary health insurance received benefits of $27. The American people spent more than $11.8 billion for personal health services during 1956. More than 25 per cent of this sum, or almost $3 billion, was covered by voluntary health insurance.*

THE ORTHOPEDIC FRAME COMPANY of Kalamazoo, Michigan, has developed the Stryker PlasterVac, a heavy duty vacuum unit which quickly and efficiently draws away all plaster dust as a cast is being cut. Persons allergic to plaster dust can now remove casts in comparative comfort. The PlasterVac is available with or without the Stryker Cast Cutter. The unit can be purchased separately and the cast cutter quickly attached. Additional information on the PlasterVac or other Stryker equipment can be had by writing: Orthopedic Frame Company, 420 Alcott Street, Kalamazoo, Michigan.

*The Foundation of the American Society of Plastic and Reconstructive Surgery, Inc. announces its 1957 Scholarship Contest. The following three groups of candidates are to be considered:*

*I. Junior Classification: (1) The contest is restricted to residents in training, and plastic surgeons who have been in practice no longer than five years. The essayists must be residents of the American continents, British Dominions or Western Europe. (2) Two awards are offered: the first consists of a six months' scholarship and the second of a three months' scholarship. The award winners will be entitled to full maintenance in all plastic surgery services listed in the Foundation's pool in the United States and Canada. Limited maintenance will be available in all foreign plastic surgery centers officially listed in the pool. The scholarship time may be divided to suit the requirements of the winners. Additional cash prizes of $1,000.00 and $750.00 will be made available to the first and second award holders, respectively, for traveling expenses. (3) Certificates of Honorable Mention may also be given, with or without a limited scholarship. (4) Character references by two leading plastic surgeons from the applicant's country must accompany the manuscript.*

*II. Senior Classification: (1) The contestants must be in active practice of plastic and reconstructive surgery for more than five years. (2) A silver plaque or certificate of honorable mention is offered for a winning essay in this classification.*

*III. Original Contributions in Plastic Surgery Field Submitted by Non-plastic Surgeons: (1) A silver plaque or certificate of honorable mention is offered for a winning essay in this classification.*

*Manuscripts will not be accepted by the Award Committee after June 1, 1957. These should be sent by registered mail to Dr. Richard B. Stark, 20 East 68th St., New York 21, N. Y.*

*The subject matter of the essay must be the result of some original research (either clinical or experimental) in plastic and reconstructive surgery and about 5,000 words in length. Papers that have been previously published (even in part) will not be accepted.*

*All essays should be submitted in quadruplicate, and in English only, with no indication of the writer's name or institutional affiliation. An additional envelope should include the con-*



CONTINUED ON PAGE 46

# PAIN-

The predominant symptom for which a majority of patients seek medical help.
For nerve block control of neuralgic phases of somatic pain, SARAPIN, the aqueous non-toxic distillate of Pitcher Plant has been used successfully by clinicians throughout the country for nearly a decade.

An extensive discussion giving details of the technique of regional analgesia may be found in our booklet "Sarapin, Injection Technique in Pain Control," and is available on request.

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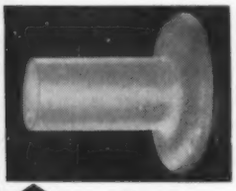

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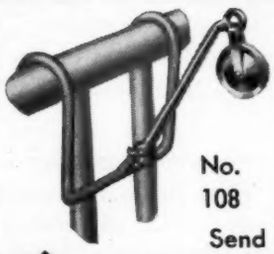

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# NOTES AND QUOTES

*testant's name, address and institutional affiliation, with details of professional training and percentage of practice in plastic surgery.*

*The award winners will present a written report before their national plastic surgery societies on their scholarship experiences. The report should be published in their plastic surgical journals.*

*The Foundation of the American Society of Plastic and Reconstructive Surgery, Inc. reserves the right to publish the submitted essays in the official journal,* Plastic and Reconstructive Surgery.

*Infraction of any of the aforementioned listed regulations will prevent participation in the contest.*

*For further information write: The Foundation of the American Society of Plastic and Reconstructive Surgery, Inc., c/o Dr. C. R. Straatsma, President, 5 East 83rd Street, New York 28, N. Y.*

ALL-TIME low death rates were recorded in 1956 for tuberculosis, maternity, the childhood diseases, suicide and homicide, the statisticians of the Metropolitan Life Insurance Company report on the basis of the experience among the company's industrial policyholders.

In addition, the poliomyelitis death rate among these insured dropped to half that for 1955, or to only .3 per 100,000. This reduction in mortality paralleled the drop in the number of cases of the disease reported in the general population of the United States. In 1956 there were 15,400 such cases reported in the country, a 47 per cent decrease from the 29,270 cases in 1955. The statisticians credit the immunization program for part of this decrease.

The cardiovascular-renal diseases accounted for a little over one-half the total deaths among the industrial policyholders in 1956. Second in rank were cancer and allied conditions, responsible for slightly more than one-fifth of the deaths. Accidents ranked third, and these three causes of death added together accounted for four-fifths of all the deaths.

Mortality incidental to pregnancy and childbirth decreased to a record low of .9 per 100,000 policyholders in 1956; this is particularly significant since the number of births reached an all-time high in the United States.

*A new Peristaltic-Action Pump which pumps either liquid or gas through rubber or plastic tubing has been developed at the National Institutes of Health, Bethesda, Maryland, and is now being manufactured by the American Instrument Co., Silver Spring, Maryland. These pumps have already been adapted for such uses as administration of sterile fluids to animals, perfusion of body organs, micrometering and transfer of pathogens from one container to another. Complete information is given in Aminco Bulletin 2288, available upon request from the American Instrument Company, 8030 Georgia Avenue, Silver Spring, Md.*

THE UNIVERSITY OF TEXAS M. D. Anderson Hospital and Tumor Institute presented the 1957 Bertner Foundation Award to John Joseph Bittner, PH.D., D.SC., the George Chase Christian Professor of Cancer Research and Director of Cancer Biology in the Department of Pathology at the University of Minnesota Medical School, Minneapolis.

Established in 1950, the award, in honor of the late Dr. E. W. Bertner, first Acting Director of The University of Texas M. D. Anderson Hospital and the first President of the Texas Medical Center, is presented annually for outstanding contribution to the field of cancer research.

*New appropriations of $700,000 for research into tobacco use and health raise to $2,200,000 the funds provided by the Tobacco Industry Research Committee since its start in 1954, Chairman Timothy V. Hartnett announced recently.*

*From these funds, research grants of over $566,000 were awarded during 1956 upon recommendation of the Scientific Advisory Board to the Committee. More than sixty independent scientists working in hospitals and research institutions throughout the country are now carrying forward their medical research under Tobacco Industry Research Committee grants which total $1,380,000 since late 1954.*

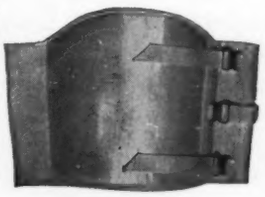
*All research grants are made by the Committee upon advice from the Scientific Advisory Board, a group of nine doctors, educators and research scientists headed by Dr. Clarence Cook Little, founder of the Roscoe B. Jackson Memorial*



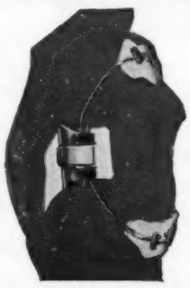
CONTINUED ON PAGE 48

## CAMP's Simple One Piece Hospital Binder

Made from white woven elastic with front panel of foam rubber vulcanized to tackle twill, faced with flannel for comfort. Three alternating buckles and straps for side closing. The high top of the front panel can be reversed for low abdominal incisions.



## CAMP Spinal Hyper-extension Brace



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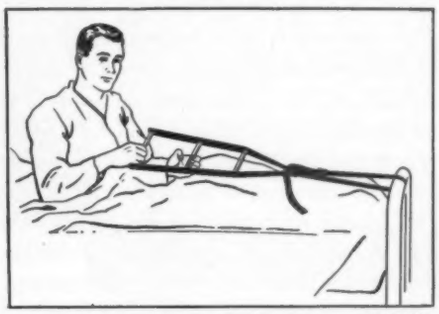

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# NOTES AND QUOTES

*Laboratory, Bar Harbor, Maine. This Board has been given full freedom in research policy and programming.*

*Dr. Little, who is also Scientific Director of the T.I.R.C., welcomed the continuing support of the Board's research program as an "expression of confidence in our allocation of funds and in the scientists who work with T.I.R.C. grants."*

*Last year, for example, grants were made, including one to the Tissue Culture Association to further the study of human body cells grown in test tubes. Also, over $60,000 was provided for fellowships to students at seventy medical colleges, $35,000 of which was for 1956 use.*

*A large proportion of funds goes for investigations into the many unresolved questions arising from charges that excessive cigarette smoking is statistically linked to lung cancer incidence.*

*"Work being done in this complex field is providing new knowledge and techniques valuable in the quest for answers to cancer control," Dr. Little said. "Despite repetition of charges of a statistical association between excessive cigarette smoking and the incidence of some lung cancer, the question of what role, if any, smoking may have in relation to this ailment remains unanswered. Efforts to find out the facts are being continued by the T.I.R.C. as well as other private and public groups supporting cancer research."*

TUMORS of the testes induced in mice by administration of a female sex hormone have the capacity to become independent of the hormone. Scientists of the National Cancer Institute have observed that such tumors, which until now have been considered dependent for further growth upon continued hormonal stimulation, can continue to grow when the stimulus is removed or when bits of tumor are transplanted into new hosts.

These findings are reported by Dr. Howard B. Andervont, Chief of the Laboratory of Biology; Dr. Michael B. Shimkin, Chief of the Biometry Branch; and Mr. Harry Y. Canter, of the Laboratory of Biology, National Cancer Institute of the Public Health Service, Department of Health, Education, and Welfare. Their paper, "Effect of Discontinued Estrogenic Stimulation upon the Development and Growth of Testicular Tumors in Mice," appeared in a recent issue of the *Journal of the National Cancer Institute.*

Knowledge of the mechanisms responsible for the appearance of malignant tumors is important to an understanding of the nature of cancer and the development of rational methods of treating the disease. In these studies the authors undertook to determine the extent to which the development and transplantation of induced testicular tumors were dependent on continuous hormone stimulation.

*Among people under forty years of age, the proportion of deaths by accident is six times greater than between ages forty and fifty-nine, and twenty times greater than at ages sixty and over, according to a report by Mutual of New York. The company, which last year paid $64,200,000 in death benefits on the lives of 11,488 policyholders, said that among policyholders under age forty, accidents accounted for 41 per cent of the fatalities. Between ages forty and fifty-nine, the ratio of accidental deaths was 6.7 per cent; over age sixty, it was 1.9 per cent. Accidents took a greater toll among younger people than heart disease and cancer combined, they reported.*

A LARGE indicating scale and pointer have been incorporated into the standard Dickson "Minicorder" to provide easy reading of temperature or pressure from a distance. These new recording indicating instruments are known as "Mindicorder." The indicator scale is mounted above the recording chart, and to provide even greater ease in reading, the single door is designed with separate viewing windows. A fluorescent pointer indicates the temperature or pressure that is being recorded on the chart below. In many instrument applications a clearly legible indication seen from a distance will save operators valuable time by making it unnecessary to step close to the recorder to read current pressure or temperature. This new instrument provides a clear indication, together with the chart of constantly varying conditions. Complete information about the new Mindicorder and the complete line of Dickson Instruments can be had by writing the Dickson Company, 7422 Woodlawn Avenue, Chicago 19, Illinois.

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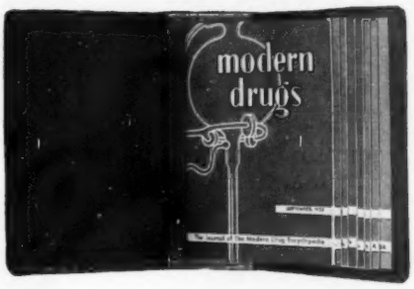


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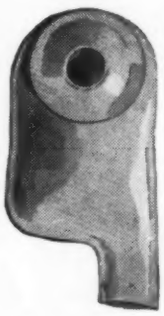

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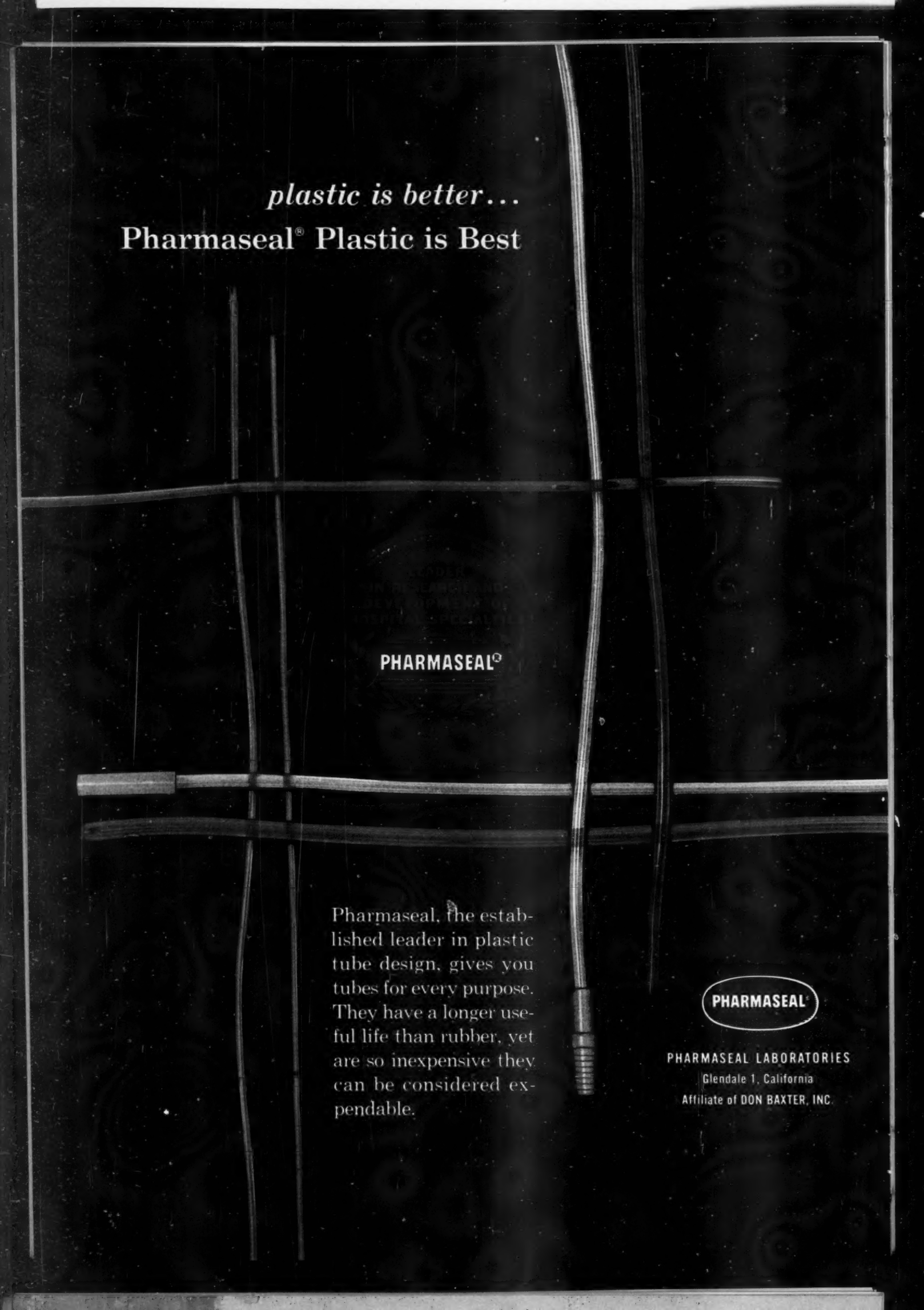
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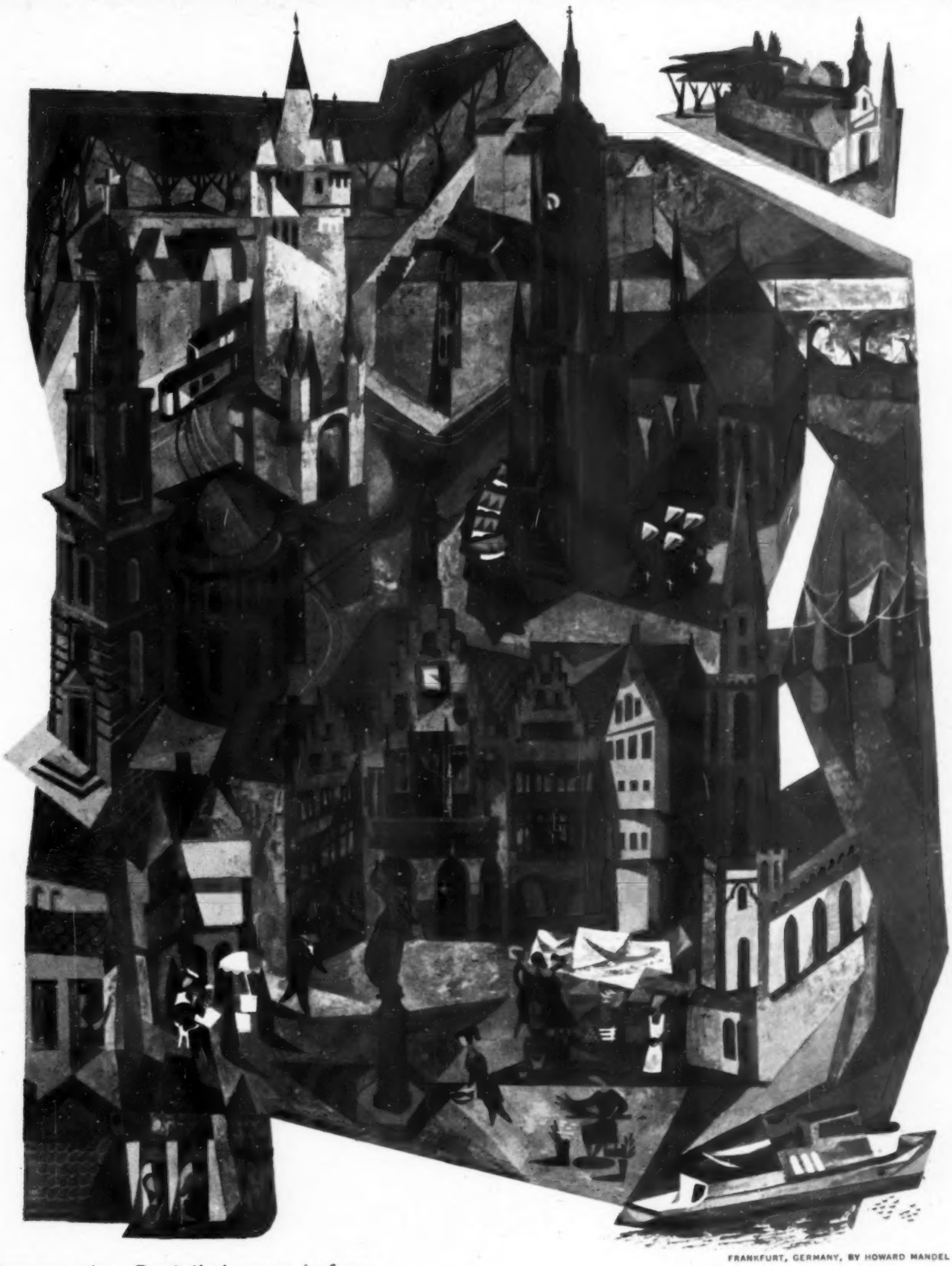

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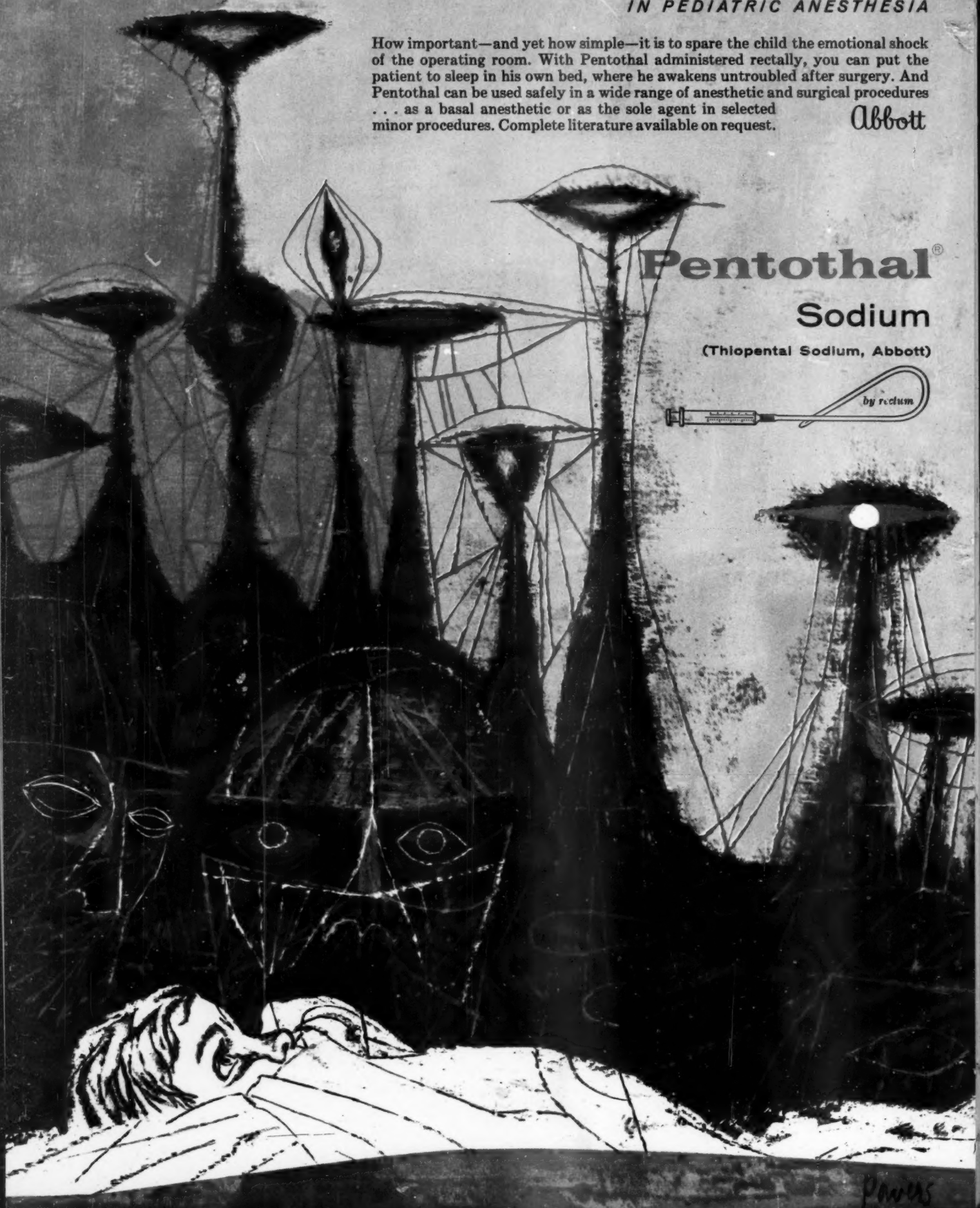

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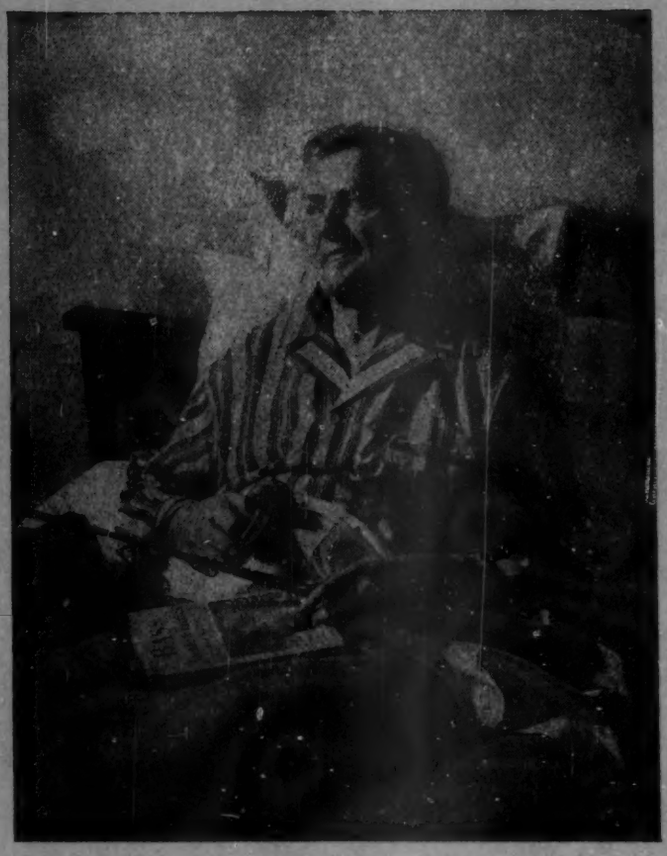

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